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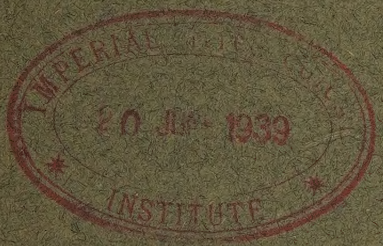

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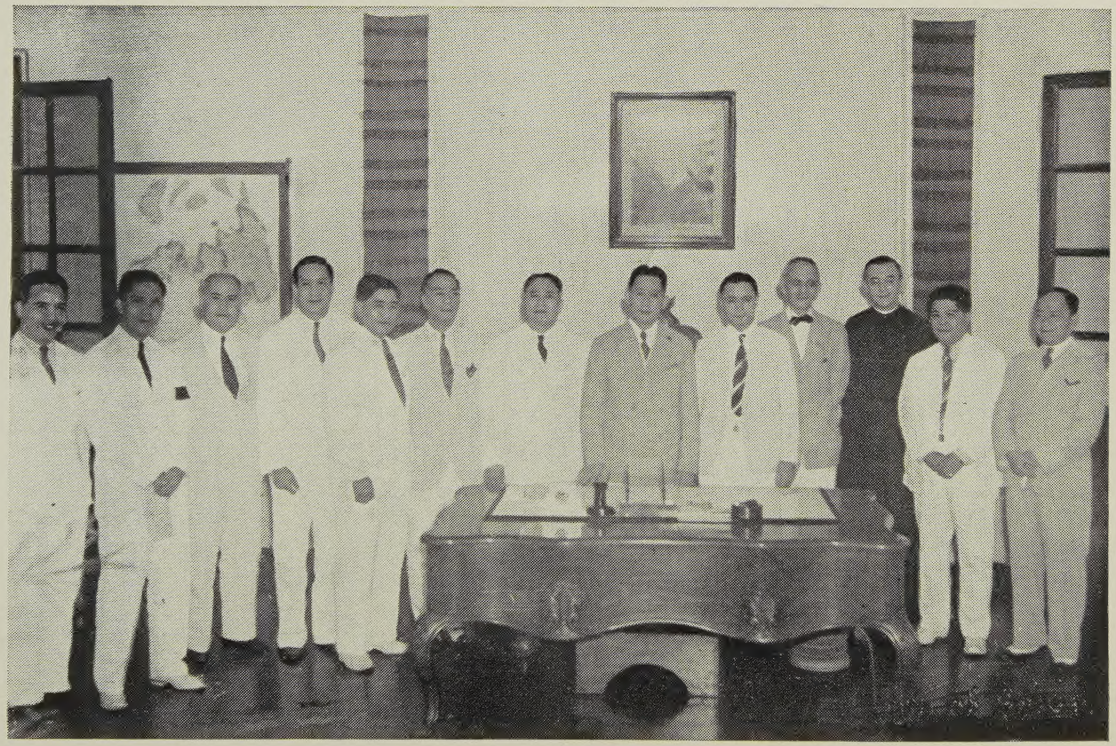

The new Secretary, Hon. Benigno S. Aquino (center) surrounded by the former Secretary, Hon. Eulogio Rodriguez (left), the Under-Secretary, Hon. José S. Camus (right), and the Directors and Chiefs of Bureaus and Offices under the Department of Agriculture and Commerce. (Photograph taken in the Office of the Secretary after his induction into office).

The Philippine Journal of Agriculture

VOL. 10 FIRST QUARTER, 1939 No. 1

A NEW METHOD IN MANGO PROPAGATION [1]

TYÔZABURÔ TANAKA

Taihoku Imperial University

FIVE PLATES

INTRODUCTION

Evergreen fruit trees, like the mango, citrus, chico, and avocado, are generally propagated by inarching and marcotting in warm countries, as it is believed that both budding and veneer grafting are not successful in the tropics. The reason is mainly based upon the fact that in cold countries one can easily utilize dormant buds which can be revived by placing them upon a functioning root stock, while in warm territories it is difficult for the budwood to harden and also the scion or buds used easily dry up with excessive heat before they become firmly established in the process of union with the tissue of the root stock. Both inarching and marcotting, besides being tedious, cannot be expected to produce a large number of vigorous young plants at one time. The resulting offspring, besides being too large to be moved thus exposing them to the danger of withering, are always weak and look old. Various methods of twig grafting have been claimed to be more satisfactory. One method is to use the whip grafted scion with a free bottom end nourished by water in tube, or inserted into moist soil. This method undoubtedly keeps the bud alive during a period long enough to perfect the union, but it requires too much labor. "Etiolation layering" is sometimes recommended to secure a large number

[1] Communications from the Horticultural Institute, Taihoku Imperial University, No. 79.

of vigorous young plants in the tropics, but it is not always successful when the soil and temperature are not ideal. Under this circumstance, a new device for side-grafting in which immature wood is used is proposed by Ichizô Nakamura of Takao, Formosa. This device works very satisfactorily under tropical conditions in multiplying mango plants in a very speedy way. This new finding is described in the following paragraphs.

THEORETICAL STARTING POINT

In temperate countries where both budding and grafting are practiced the scion species used are mostly deciduous and the buds are dormant when cut, as those on immature wood are hard to revive. In tropical countries, in the case of the mango, the development of the bud does not require a long period of dormancy, and soft wood buds can be used for grafting purposes. Moreover, the healing of the wound is much easier when the plant is active in midsummer up to early fall when the temperature is high and the regenerative power is strong. In early spring the temperature is not high and the plant is more dormant than in summer and this gives a different effect to the plant. The root stock to be worked is also larger and more vigorous with the advance of the season and it is easy to force the bud to start strong growth. This supports the theory that spring is not the proper season when to practice grafting in the tropics, since the physiological and morphological conditions of the stock plant are, in summer rather than in spring, far more conducive to make the wound heal faster, force the inserted bud to grow easier, and complete the elongation of the shoot faster. It does not require an entire season to expect a full wood growth, as the growing season is long and the temperature favors a rapid elongation. Another important difference is the evaporation power. Ordinary scions used in the temperate countries in spring are dormant and keep a considerable length of time without losing their power of regeneration as the physiological activity is slow. Scions used in the tropics, on the other hand, are always active and ready to function even during winter, and are ever subject to lose water by transpiration and respiration. Under this condition, the scion must be properly protected against loss of water, and the budwood must be waterproof as far as possible. To answer this requirement, budwoods must have neither foliage nor petiole, and the leaf scar should be water-tight with complete cork formation after the natural abscission of the petiole. This can be attained by removing the leaf blade at the middle of the petiole, before the scion is cut, and by

waiting a week or so, the remaining petiole falls down with the formation of an abscission cork layer. Such wood is ready to be used as a scion. Without doing this, and if the leaves are removed at the time when the scion is cut, the cut surface of the petiole is likely to form a danger point, from which water may evaporate very quickly. Such scion will wither very rapidly and will not survive at all when used. Defoliation and healing of the leaf scar will unquestionably prevent the loss of water by the bud. Not only that. They accelerate the subsequent development of the bud into a sprout. The pre-curing of bud by defoliation renders the scion ready to start bud growth when used. This point is well explained in Mr. Nakamura's method and the factors which cause the failure of grafting in the tropics are wisely avoided and more logical processes substituted.

METHOD OF GRAFTING

In Mr. Nakamura's method, terminal or lateral buds, in an intermittent rest period between two cyclic growths, are to be used. If the terminal bud is wanted, several leaves from the top are removed, and the scion with two or three leaf scars is to be cut after the abscission of the petiole. The lower portion of the same stick can be used again, after two weeks or so, in the meantime waiting for the terminal cut to heal completely. After removing the leaf blade and the remaining petiole, the top part with several leaf scars, can be used as before for the scion. This time, the axillary buds in the uppermost position are to be developed. In a similar way, the still lower part of the same stick is available. It is better to remove all leaves of the entire shoot at the beginning, if several scions are to be obtained from the same shoot. (Plate 5, A, B, C).

The scion is inserted into the notch made on one side of the immature but fully developed root stock, while the bark is still green. Two- or three-year-old stocks with brown barks are also available but they are not so good as the green ones. Still larger stocks over two centimeters in diameter should be cut back when worked on with young sprouts. When the stock is old and top working is desired, the entire trunk is cut down in early spring at a point 15 to 18 cm. from the ground. From several adventitious sprouts arising near the cut surface, one or two opposite strong shoots may be saved, and such vigorous shoots are used when they grow big enough to work on. It does not matter how big the stock is, but the part to work on must not be fully mature

and dormant. When working on young plants, the stock is cut at a point 5 to 10 cm. from the ground, leaving two or three leaves, which are left untouched when the scion is inserted. (Plate 5, E).

THE ROOT STOCK

The most economic and speedy way is to use one-year-old root stock, and operate in mid-summer of the same year. The mango fruits chosen to supply seed for stock, must be large enough in size, if the plant is a seedling type, and it must represent a good early strain. It is not necessary to use the seeds of big varieties, like the Carabao or Golek, because all seedling types supply good stock plant for these standard mangoes. If the Carabao mango seedling is used as the root stock of the White Golek, the scion will always outgrow the stock, but the stock of the seedling type of the mango will grow just as big as the scion or will slightly outgrow it, whenever the Carabao or White Golek is worked on to it. The seeds are planted in pots or in the ground 60 cm. apart, after removing the shell. The planting soil must be well prepared and rich in organic matter. After sowing the seeds, it is desirable to have a thin sand dressing on the surface. Upon germination of the seeds, they must be tested to show only a single plant from each seed, and smaller poly-embryonic secondary sprouts must be scraped off while they are young. The seedlings should be well fertilized to allow them to attain their maximum height and girth. In starting the work, the bigger seedlings are to be worked on first, the smaller ones next. The cutting back of the top of the stock must not be carried down too far away from the parts having closer leaf stand. In top-working old seedlings, the best results may be obtained when the plant is rather large, having at least a diameter of 12 to 15 cm. That transplanting may be made easier the seed should be planted in a longitudinally halved pot. (Plates 2, 3, 4).

OPERATION AND TYING

The bottom of the scion must be cut very sharply to make an acute wedge, but one side must be cut along the cambial layer as far as possible, so that both sides are not symmetrical. The cut surface must be very smooth, allowing a single draw of the knife to make an even plane. The stock is then notched by cutting it down diagonally, and the knife must be drawn straight down to make the oblique cut very sharp and even. The side to be

incised must be as straight as possible. Curves should be avoided. It is preferable to work on the eastern side, as the afternoon sun may injure the graft when it is done on the western side. The wood tissue should not be cut too deep into and the incision must not be too far away from the cambial layer. The scion wedge to be well placed must be inserted in air-tight contact with the incision surface. The tongue-like portion of the bark must not be broader than the stock notch, even if the scion is thicker than the stock. In other words, the cambial plain of the former must be completely concealed within the incision of the stock. All precaution must be taken to make the scion wound perfectly covered by the cut surface of the stock. The air-tightness of the contact surface would decide whether the union is successful or not. A long exposure of the cut surface of the scion must be strictly avoided. Therefore, the scion ready to be used must be kept, during the operation, in a tall box to prevent its cut surface drying up. The best kind of knife to use in mango grafting is one having a blade of stainless steel and sharpened on one side only. By using such a knife, oxidation of the cut surface can be prevented. The sharp edge of the knife must be straight so as not to cause any curvature on the cut surface. The best type of tying material is ordinary cotton string tape commonly used in the shop, which is composed of several thread lines pasted flat in one narrow strip. The tape must be wound close and tight so as to exclude air. Such tape will be removed one or two months after the taking of the scion when it will have increased in volume. Waxed cloth tape generally used in budding is not satisfactory, as it prevents the quick swelling of the scion in action. (Plate 1 and Plate 5, F).

TREATMENT AFTER THE OPERATION

No cover is necessary to protect the graft even in strong sunshine. After two weeks, the uppermost bud of the scion begins to swell. If it looks difficult to judge whether the graft was successful or not, observe at night with the use of a flashlight. The surviving scion looks lustrous and turgid. After the third week, the bud starts its initial growth. The internal activity of the living graft can be easily detected with the frequent visit of ants, seeking the sugary secretion of the new growth. At this time, the top of the root stock may also show new growth. These stock shoots must be shaved off with care as soon as they start to elongate. When the new growth of the scion develops

and reaches a length of 30 cm. or so, the remaining top portion of the stock must be sawed off carefully at a point 5 to 8 mm. above the union.

If the scion did not take, the same stock can be worked again at the opposite side a little below the original incision.

Since no cover is used in the present method, precaution must be taken not to leave any wound of the scion in contact with the air. The success of the graft is therefore dependent upon the skill of the operator. Covering the grafted portion with soil helps injurious fungi or bacteria to the wound.

DISCUSSION

Mr. Nakamura's side working method of the mango is a good example of "soft wood grafting" which is generally believed unsuccessful in the tropics as well as in the colder countries. He found that the failure lies principally in the inadequate condition of the scion, and the lack of proper attention to safeguard its activity. The immature bud does not develop in most of the temperate species, except in a few, like the apple, plum, and the cherry. With most of the tropical species, however, it is easier to make such immature bud start growth, provided the forcing is done effectively. This can be attained by pre-curing the bud through defoliation and putting it into a vigorously growing stock during the active growing season, not in the springtime when the bud is semi-dormant. The strong seedling cut in summer or early fall can easily stimulate the inserted bud to growth, after a certain period of curing caused by the natural drop of the petiole which, in turn, is forced by the removal of the blade. At the same time the scion is almost water-proof as the petiole scar is already well coated with cork tissue thus preventing evaporation. All these factors favor the rapid healing of the union and the easy development of the new bud. At the end of the fall, an already well developed nursery plant can be secured, and a large number of similar plants will then be available as a good supply of the budwood can be had at intervals of approximately two weeks, as stated in the preceding paragraphs. The entire grafting work is complete at the end of the year the seeding of the stock plant is started and the resulting young plants are ready to be transplanted in the next spring. In this way standard varieties, like the Carabao and the White Golek, can be obtained in a large number within a very short time. This gives an opportunity to mango planters to raise more plants

of the desirable variety with less expense and labor. This fact also suggests the possibility of the mango trees being planted on a large scale as a plantation crop, since the demand for fresh fruits has increased after the invention of preparing the frozen mango meat for use in ice-cream manufacture. The canning of the mango meat is also a great possibility in tropical countries. Fruits of such varieties like the Carabao and the White Golek can be picked green before the mango fruit fly, *Chaetodacus dorsals* Hendel has a chance to attack them. They can then be satisfactorily transported and marketed before they get over-ripe. It is hoped that the present paper may be of help in the future development of the mango industry in the Far East.

ILLUSTRATIONS

Plate 1

Young stock plant cut back (one leaf remaining) with the scion already side-grafted. Note new shoot with a whorl of already developed leaves. Photographed on June 20, when there were still mango fruits in the market (left, Carabao; right, seedling type).

Plate 2

Vigorous new shoots of two scions side-grafted on two opposite stocks arising from a large mango branch. Branch and stocks have been cut back. This was done in early fall when Kaki fruits could still be purchased in the market (two fruits are shown at the bottom).

Plate 3

Stocks in row, photographed on June 2. *A*, side graft showing the scion with complete first cyclic growth. *B*, older side graft showing the top of the scion already removed. The scion had already completed the second cyclic growth. *C*. same as *A*. *D*, stock with one shoot saved, ready to be top-worked. Originally top of stock was cut back and one shoot saved from resulting adventitious buds. The new shoot is shown already making the third cyclic growth.

Plate 4

The same stocks, photographed on July 15. *A*, side graft showing the scion with complete second cyclic growth. The top of the stock is ready to be cut off. *B*, new shoot with complete third cyclic growth. *C*, same as *A*. *D*, the top of the stock shoot was cut back and side grafting done after taking the photograph shown in Plate 3. The new scion has already completed the first cyclic growth. Photographs taken when mango fruits could still be purchased in the market (left, seedling type; right, Carabao).

Plate 5

A, typical mango budwood. *B*, leaves are removed by cutting them off at the petiole. *C* and *D*, natural abscission of the remaining petioles. *1*, *2*, *3*, pieces available for scion. They are to be cut off from the top at intervals of about two weeks, as soon as the cut surface is healed. *E*, side grafting on a root stock cut back. *F*, the same, tied with narrow thread tape.

PLATE 1.

PLATE 2.

PLATE 1

PLATE 4.

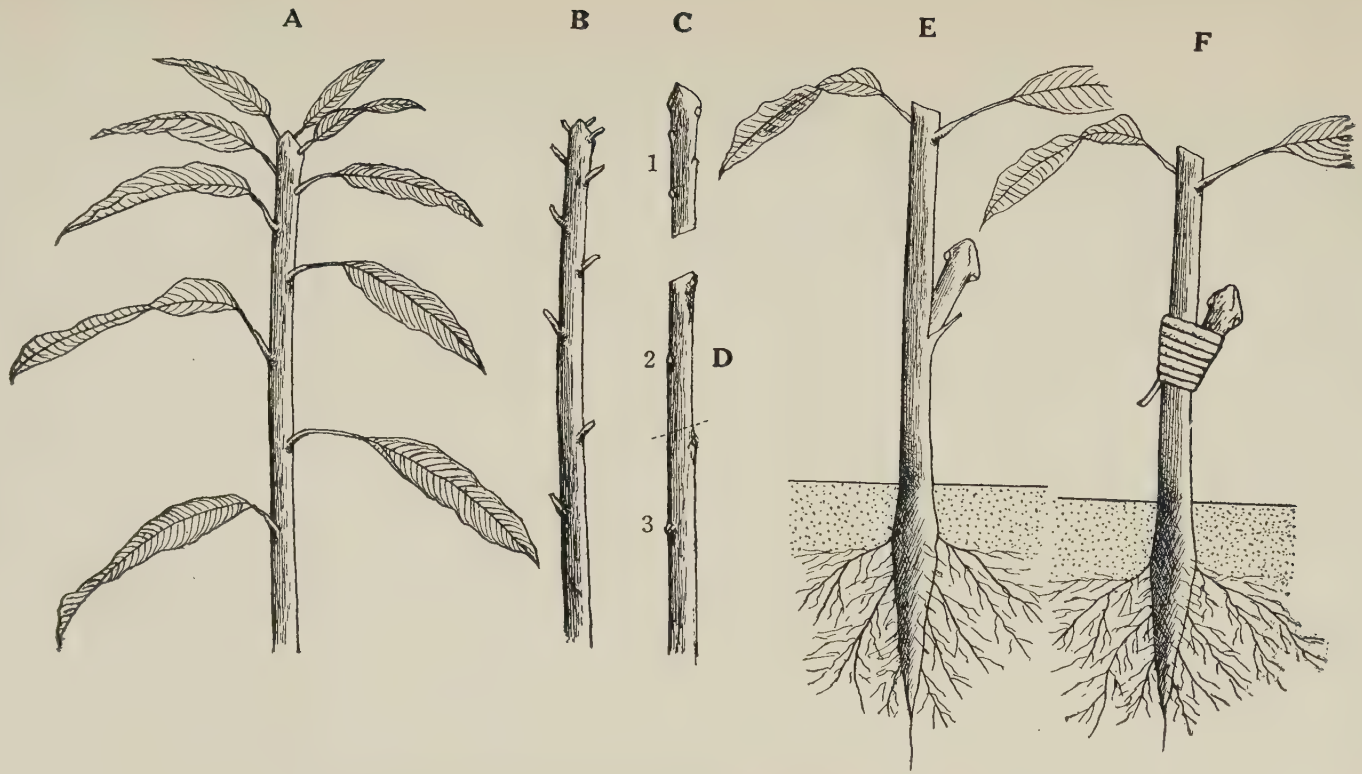

PLATE 5.

SOME NOTES ON TONGUE-INARCHING OF THE AVOCADO

By Juan P. Torres

Of the Bureau of Plant Industry, Manila

EIGHT PLATES AND TWO TEXT FIGURES

The vegetative propagation of plants, known as tongue-inarching which is briefly described in this article was first practiced successfully with the avocado at the Economic Garden, Los Baños, Laguna. The same method of inarching is termed "whip grafting" or "grafting by approach" and is briefly described in the Standard Cyclopedia of Horticulture, Volume III F–K, page 1370. As a part of the lecture on Plant Propagation, this method was demonstrated by the writer to most of the trainees under Commonwealth Act No. 85, while in their training period at the Economic Garden. To these trainees who are now stationed in many parts of the country, from northern Ilocos down to Sulu Archipelago, this method was locally referred to as the E. G. method of inarching, to differentiate it from the ordinary method of inarching.

PREPARATION OF STOCKS AND SCIONS

The stocks for inarching must be in a vigorous growing condition before attempting to unite them with the twig-scions. The seeds may first be grown in seed flats and then potted as soon as they have germinated. Pots not less than four inches, inside diameter, or good sized bamboo joints may be used for the purpose. Always use rich loam or sandy loam soil. If for any reason the seedlings had been grown in the nursery rows before potting, larger sized pots must be used. For extra large-size seedlings half or whole empty petroleum 5-gallon cans should be employed.

After the seedlings are well established in the pots and are growing vigorously, inarching may be done on any part of the tree, either near the ground if the branches are low or high up on the tree. In the latter case the pots with seedling stocks may be "hung on a branch near the twigs to be inarched,"(1) Plate 1. With side branches, a platform or a stout scaffold

should be constructed at a suitable level around the tree which will furnish the twig-scions, Plate 2. The scions should be the most vigorous twigs and, if possible, of the same size as the stem of the intended stocks. Stems of stocks and scions of the same size may not be very essential for a stock a little larger than the twig-scion will also make a perfectly good union provided that both of them are in a vigorous growing condition.

Method of inarching.—As in the ordinary method of inarching(2) (3), the bark and part of the wood of both the stock and the scion are removed with a clean cut by means of a sharp knife. As much as possible both cuts should be of the same width and length, about 2 to 3 inches long, so as to make a snug fit when the two cut surfaces are brought together. Then, a little below the top of the cut surface of the stock make a split downward, figure 1(*a*), and another same-sized split upward or "tongue" on the cut surface of the twig-scion, figure 1(*b*), and then the stock and scion are brought together as shown in figure 1(*c*). The "tongue" on the twig-scion is inserted into the split on the stock so that the cambia of the stock and scion are brought into as much as possible a close contact. Held firmly in such position, they are then bound together by wrapping with budding tape or waxed cotton twine. Both the pot with the stock as well as the twig-scion are fastened firmly so as to prevent dislocation of the stock and scion by any movement due to wind or otherwise.

During rainy days one must be sure that, after tying, no water enters the wound, otherwise there will be no union. The stocks should be regularly watered when the weather is dry so as not to retard the union and produce weak inarched plants.

Three to four weeks after inarching, to be more exact, 25 to 30 days, the top of the stock may be removed by cutting off obliquely at a point shown by the tip of the pruning knife on the left side, Plates 3 and 4. The cut surface should be painted with either white lead or asphaltum. By this time the stock and the scion had already united to a greater or less extent. A cut on the side about one-half of the stem in depth is made into the wood of the scion as shown by the point of the budding knife on the right side, Plates 3 and 4. Within two weeks or more after the first cut is made the appearance of vigorous shoots in the scion indicates that the sap is moving freely through the union. No sooner has such growth started than the

inarched plants are severed from the mother plants, Plate 5. The cut surface is smoothed with a sharp knife and, as before, painted with either lead or asphaltum. Thereafter the inarched plants are kept temporarily in a plant shed until they become

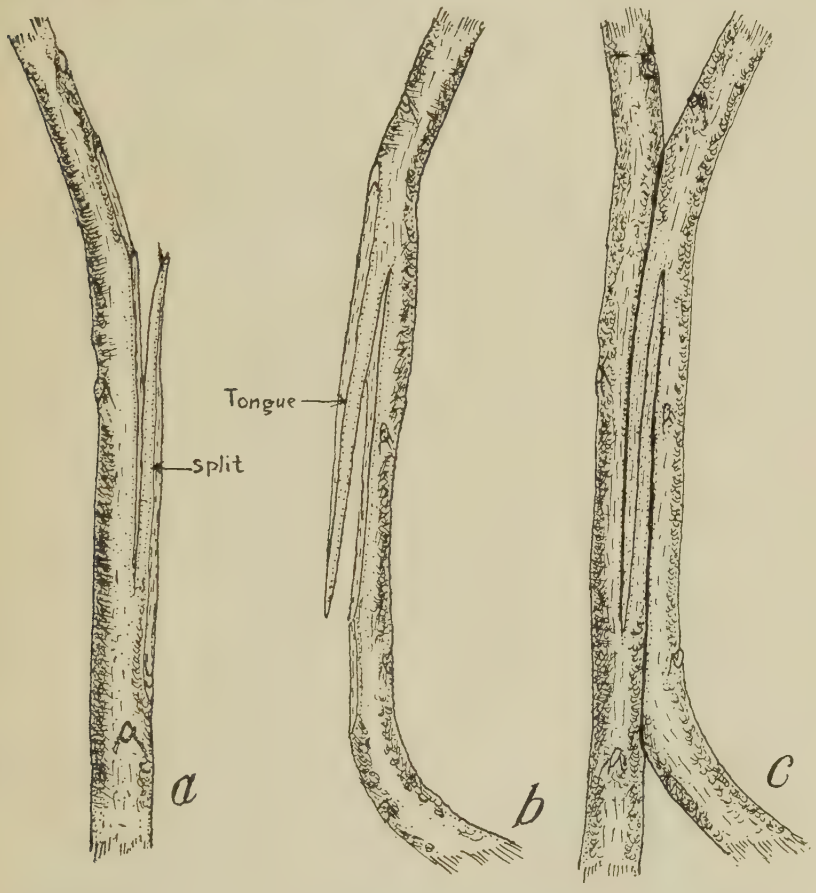

FIG. 1. Illustrations to show (*a*) the downward split on the stock (*b*) the upward split or tongue on the twig-scion and (*c*) the stock and twig-scion being brought together.

fairly well established. Then they are set in a half-shaded place until they develop a perfect union and strong tops, Plate 6, when they are ready for transplanting.

TONGUE-INARCHING VERSUS ORDINARY METHOD

With the method just described in the preceding paragraphs it is very plain that the line of contact between the cambia of the stock and the scion has been greatly increased. As may be

seen in the illustration, Fig. 2(*a*), the ordinary method of inarching has only one line of contact whereas, in the improved method, Fig. 2(*b*) there are three lines of contact, hence a greater chance for union. Because of this increased line of contact between the cambia of the stock and the scion in the modified method, the period from the date of inarching to the date of severing the inarched twigs from the mother plant has been

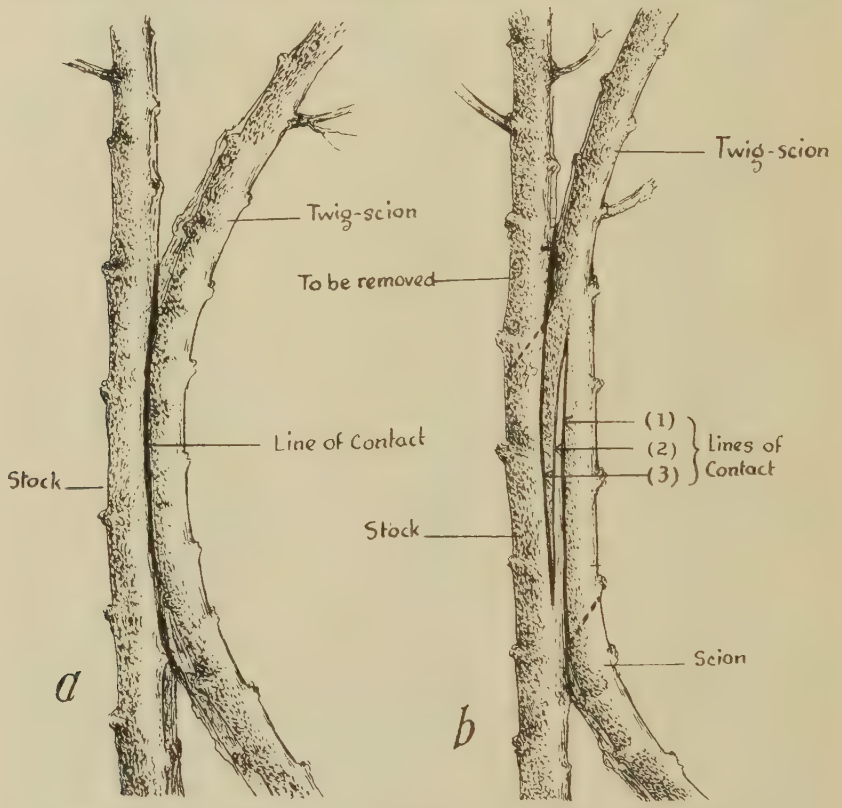

FIG. 2. Illustrations to show the line of contact between the stock and the scion in (*a*) ordinary inarching and the three lines (1, 2, and 3) in (*b*) the improved method of inarching. The dotted lines indicate where to cut off the top of the stock and where to sever the inarched twig from the mother plant.

shortened by four weeks or more. With the ordinary method of inarching this period takes from 8 to 12 weeks or more.

The inarched plant by this method is more firmly united with the stock because of the "tongue" of the scion which is inserted into the split in the stock. Obviously the inarched plant is in fact a "tongue grafted" plant. For the same obvious reason the sap flows more freely through the union thus resulting in a more rapid development of the inarched plants.

A set of 100 twigs of the avocado, Batangas Cardinal No. 2, were inarched using the improved method. On the twenty-fifth day all the tops of the *stocks* had been removed and in *42 days* from the date of inarching, all except two twigs had been severed from the mother tree. One of the twigs broke off on the thirtieth day as the pot bearing the stock fell to the ground. This particular branch continued to develop but very slowly. The other stock used was too young and was badly infected with a fungus disease which proved fatal. Three other twigs developed very slowly and, upon examination, they were found to unite with the stocks only in the line of contact No. 2, that is, between the tongue of the scion and the split in the stock. Nevertheless, three to four weeks later, both of them had developed normally. This preliminary trial with tongue-inarching gave about 95 per cent perfect union. On the other hand, of the 30 twigs inarched with the ordinary method, which were severed 3 months after inarching, two died in two weeks and six were apparently very weak; hence there were only 20 living twigs or 66 per cent perfect union.

In ordinary inarching a perfect union may be obtained when the stock and scion are both in vigorous growing condition and of the same size but in tongue-inarching, the stocks and the scions may be of unequal size. If not as large as the twig-scion, the stock must be a little larger, if there should be any difference in size. This does not mean that stocks that are smaller than the twig-scions will not unite as it has been observed that they do unite equally well with the improved methods of inarching. The part just below the union, however, may remain small for a considerable length of time.

TONGUE-INARCHING VS. OTHER METHODS OF PROPAGATION

Tongue-inarching on the avocado may now be compared with such other methods as marcotting, grafting and budding. Experience has shown that most of the avocado varieties do not root when marcotted. Some avocado trees may root but the percentage of success is too low to recommend the method for commercial propagation. San Pedro (4) stated that all the 182 branches in 3 avocado trees which he marcotted had formed complete calluses in 6½ months and there had appeared prominent protuberances in the upper region of the ring, which he found, had given rise to roots a month after excising the

calluses below them. From his trials he obtained a very low percentage of perfect rooting. With the avocado, therefore, marcotting is an operation that requires a much longer period to perfect but gives a lower percentage of success than tongue-inarching.

The propagation of the avocado by grafting is more exacting in the vigor and size of stocks as well as in the quality of bud-sticks for scions than in improved inarching. The percentages of success obtained in the Economic Garden at Los Baños, Laguna ranged from 20 to 40 per cent in spite of considerable skill in performing them.

Budding is the commercial method of propagating the avocado. It requires no less amount of skill than grafting to perform it successfully. The best season for budding is during the cool months, from the latter part of November to the first week of March. The rainy season is indeed an unfavorable time for budding the avocado for most of the buds drop off and the shields become "blind." In exceptionally favorable season the highest percentage of success obtained from budding the avocado was about 65 per cent, and 30 to 40 per cent success is a fair general average. There are types of the avocado that, due to poor quality of their buds, are not so easily propagated by budding. Tongue-inarching seems to do well with them. Unlike grafting and budding, tongue-inarching may be more easily done during the wet season as then the stocks need less frequent watering than during dry weather. However, with an adequate water supply inarching may be done successfully in both seasons, wet and dry. With fast growing selected types of avocado plants in the orchards having numerous low set branches, it is certainly not only advisable but also more profitable to adopt tongue-inarching for commercial propagation than merely pruning them off as useless or undesirable branches. This improved method of inarching can easily make use of overgrown stocks unsuitable for budding and grafting, and it would undoubtedly serve well as a supplementary method of propagation during rainy days when budding and grafting are less successful.

APPLICATION OF THE TONGUE-INARCHING METHOD

Tongue-inarching has been found to be successful with many other plants such as chico, lanzon, sweet guayabano, caimito, rambutan, atemoya, biriba, and seedless mabolo but has not been used so extensively with these plants as with the avocado.

Recently, however, the Plant Propagation Division of the Bureau of Plant Industry tried this method in the multiplication of rambutan, with rambutan stocks, Plate 7; and Ponderosa chico with St. Croix chico as stocks, Plate 8, so as to supply the demand for these fruit trees. In the Economic Garden, the new method has been tried successfully on lanzon stocks, and on longan with lichi seedlings as stocks. It is also believed that this method may be easily adopted in the propagation of other fruit plants such as grapes, if it is desired to provide better root systems, using the most adaptable variety as stocks for the newly introduced ones. In this case rooted cuttings of both the stock and the scion should be inarched.

SUMMARY

The method of propagating the avocado described in this paper is a modified method of inarching, a combination of ordinary inarching and the so-called "tongue grafting."

In this method the line of contact between the cambia of the stock and the scion is greatly increased, thereby shortening the period from inarching to the date of severing the inarched twigs from the mother plant by four weeks or more.

The preliminary trials with the improved method versus the ordinary method showed 95 per cent perfect union for the improved or E. G. method of inarching as against 66 per cent for the ordinary method.

Not only has the new method yielded decidedly better results than marcotting and grafting with the avocado but with its use overgrown stocks unsuitable for grafting and budding can be easily utilized to advantage. Finally, it serves well as a supplementary method of propagation in the nursery during rainy days when grafting and budding can not be done very successfully.

Tongue-inarching had been tried with success on chico, lanzon, sweet guayabano, atemoya, biriba, seedless mabolo, and others.

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ILLUSTRATIONS

PLATE 1

Inarching on a high branch of an avocado tree.

PLATE 2

Showing a platform built at a suitable level around the tree. The platform carries the twig-scions, for inarching, in pots.

PLATE 3

Three weeks after inarching, with the binding tape partly removed to show the callus growth along the wound. Note the positions of the knives, showing where to cut off the top of the stock and where to sever the inarched plant from the mother tree.

PLATE 4

A closer view of Plate 3 showing in detail the callus formation.

PLATE 5

Tongue-inarched plants in empty 5-gallon petroleum cans just severed from the mother tree. Note the vigor of the tops and the formation of young leaves.

PLATE 6

A 5-month old inarched avocado plant ready for transplanting.

PLATE 7

Inarching rambutan by the E. G. method at the Central Experiment Station, Manila.

PLATE 8

Inarching Ponderosa chico by the E. G. method, using St. Croix chico as stocks at the Central Experiment Station, Manila.

TEXT FIGURES

FIG. 1. Illustrations to show (*a*) the downward split on the stock, (*b*) the upward split or tongue on the twig-scion, and (*c*) the stock and twig-scion being brought together.

2. Illustrations to show the line of contact between the stock and the scion in (*a*) ordinary inarching and the three lines (1, 2, and 3) in (*b*) the improved method of inarching. The dotted lines indicate where to cut off the top of the stock and where to sever the inarched twig from the mother plant.

PLATE 1.

PLATE 2

PLATE 3.

PLATE 4.

PLATE 5.

PLATE 6.

PLATE 7.

PLATE 3.

THE PILI NUT IN THE BICOL REGION

By Epitacio A. Lanuza
Of the Horticulture Section, Bureau of Plant Industry

FOUR PLATES

INTRODUCTION

Included in our agricultural wealth, still barely tapped, figures the pili nut which is perhaps the second most important nut fruit in the Philippines. Although considered a natural product of our country, found wild or semi-wild in many parts of the Bicol region, Mindoro, Tayabas, Laguna, Visayan Islands, and Mindanao, and although the nuts are considered exquisite by many, a majority of the people in the Islands, not to mention other countries, do not know the excellent qualities of this nut. It is a fact that in Europe as well as in America many have not even heard of the name, much less tasted the nut or preparations made from it. It is, however, very probable that, once this nut enters the world's market in good condition, it will offer stiff competition to the other nuts of commerce.

BOTANY

Pili belongs to the Family *Burseraceæ* to which also belong quite a number of species. According to Merrill (1) there are four genera under this family, of which Canarium is one, and about 40 species in the Philippines. Of the genus *Canarium* he has mentioned there are about 35 species in the Philippines.

Some authorities believe that there are three or four species of pili in the Islands, of which only two yield the highly priced nuts. These are *Canarium ovatum* Engl. and *C. luzonicum* (Blume) Gray, with the following descriptions:

C. ovatum is a fairly big tree that reaches a height of about 20 meters and a trunk diameter of about 40 cm.

Leaves alternate and compound with opposite smooth leaflets which are rounded at base and pointed at tip. Leaflets from 10 to 20 cm. long.

Fruits 6 to 7 cm. long, light greenish or yellowish green when young, turning deep maroon to violet black when ripe. The fruit consists of a thin to fairly thin pulp covering the triangular nut that has rather hard and thick shell.

The pulp is edible when cooked and contains an oil which is occasionally extracted locally for lighting and cooking purposes.

Kernel rich in oil, sweet, and suitable for culinary purposes; deliciously flavored when cooked.

C. luzonicum reaches a height of about 35 meters and a diameter of one meter.

Leaves odd pinnate with three pairs of opposite leaflets that are smooth, pointed at apex and rounded at base. Leaflets measure from 12 to 20 cm.

Fruits oval-shaped, about 3 cm. long, containing thick shelled triangular nuts with edible kernels covered by pulp as those of *C. ovatum.*

BEGINNING OF THE INDUSTRY

There seems to be no definite record as to when pili became first known nor when it became cultivated in the Bicol region. So far as the writer is aware there is no literature on the subject. Suffice it to say that trees a hundred years or more old are found in many places in the region and have been taken advantage of by the people. It must be admitted therefore that the plant must have been known in this region long ago.

PROGRESS OF THE INDUSTRY

The advance registered by the pili industry in acreage and in the uses of the nut since its introduction to many farms in the region has been quite slow as may be seen from the following tables:

TABLE 1.—*Showing the acreage and number of trees in the Bicol mainland.*

Provinces	Years							
	1932[a]		1933[b]		1935[c]		1936[d]	
	Area	Trees	Area	Trees	Area	Trees	Area	Trees
	Ha.		*Ha.*		*Ha.*		*Ha.*	
Albay	460	57,490	477	59,670	482	60,200	477	59,650
Camarines Sur	297	37,130	313	39,060	309	38,600	311	38,850
Camarines Norte	45	5,560	42	5,230	54	6,740	56	6,980
Sorsogon	214	26,770	225	28,170	244	30,500	246	30,720

TABLE 2.—*Showing the number of bearing and non-bearing pili trees in the Bicol mainland.*

Provinces	1933[b]		1935[c]		1936[d]	
	Bearing	Non-bearing	Bearing	Non-bearing	Bearing	Non-bearing
Albay	45,670	14,000	46,220	13,980	45,190	14,460
Camarines Sur	29,160	9,900	29,010	9,590	29,840	9,010
Camarines Norte	3,760	1,470	4,120	2,620	4,200	2,780
Sorsogon	21,880	6,290	22,260	8,240	22,830	7,890

[a] Statistical Handbook of the Philippines. 1932.

[b] The Philippine Statistical Rev. *1*:4. Fourth Quarter.

[c] The Philippine Statistical Rev. *3*:4. Fourth Quarter.

[d] The Philippine Statistical Rev. *4*:1–2. First and Second Quarters.

TABLE 3.—*Showing the average yield per tree.*

Provinces	1932[a]	1933[b]	1935[c]	1936[d]
	Kilos	*Kilos*	*Kilos*	*Kilos*
Albay	44	45	42	41
Camarines Sur	25	29	30	30
Camarines Norte	38	39	38	45
Sorsogon	33	34	31	31

[a] Statistical Handbook of the Philippines. 1932.
[b] The Philippine Statistical Rev. *1*:4. Fourth Quarter.
[c] The Philippine Statistical Rev. *3*:4. Fourth Quarter.
[d] The Philippine Statistical Rev. *4*:1–2. First and Second Quarters.

It can be seen from these tables that the production of, and acreage devoted to pili, has not increased much due possibly to the semi-wild state of the trees, and to a poor comprehension of its possibilities. An actual count of fruits of a fairly good bearing tree at Banao, Guinobatan, Albay, showed 10,000 nuts produced by a tree about 45 years old. These make up about $4\frac{1}{2}$ sacks of fresh fruits or 83 kilos of air-dried nuts.

Pili nuts, although not so well cared for as they should be in the region, mean something in the economic set-up of the Bicolanos. For instance, in 1934 pili as a crop ranked 6th in value in the agricultural production of Albay, yielding nuts valued at ₱86,710; 9th in Camarines Norte with ₱8,410; 5th in Camarines Sur with ₱66,840; and 8th in Sorsogon with ₱38,830. (2)

There is none that can be considered a real plantation so far in the region, the present trees being either wild or semi-wild. In most cases they are, intentionally or unintentionally, used as shade trees for abaca; or, are planted together with coconut trees. A very negligible number are planted and cared for, save those set around school houses, around yards or houses, and along highways. Practically all trees have been or are "chance" growths—from fallen fruits carried away by birds.

Although quite a number of trees have been felled for fuel or in making way for a clearing, the number of trees planted is slowly but steadily increasing.

DISTRIBUTION

Albay.—Of the 16 municipalities of Albay mainland, namely, Libon, Polangui, Oas, Ligao, Guinobatan, Jovellar, Camalig, Daraga, Tabaco, Malilipot, Legaspi, Manito, Libog, Bacacay, Malinao, and Tiwi, most of the trees are found in the towns of Guinobatan, Ligao, Camalig, Daraga, Tabaco, Malilipot, and

Libog—municipalities immediately surrounding the Mayon volcano—although trees may also be found in the municipalities of Bacacay, Malinao, Tiwi, Polangui, and Jovellar especially among the abaca plantations.

Again, it may be stated that even in the municipalities having the most pili trees, their distribution is confined to some barrios. For instance, in Guinobatan most trees are located in barrios Banao, Binogsacan, Mauraro, Masarauag, Muladbucad, Bubulusan, Balobago, Agpay, Tagbac, Lomacao, and Malipo; in Ligao, barrios Bantayan, Abibling, Nasisi, and Barayong; in Daraga, barrios Palañgo, Gapo, Anislag, Kilicao, Tagas, Madaat, Inarado, Balinad, and De la Paz. The same is true with the other municipalities (see map).

Camarines Norte.—This province has relatively fewer trees than the other provinces of the Bicol mainland. Of the 9 municipalities, namely, Basud, Daet, San Vicente, Talisay, Indan, Labo, Paracale, Pañganiban, and Capalonga only Basud, Daet, Indan, and Labo count with an appreciable number of pili trees. Observations seem to indicate that, as in Albay, the pili trees are found to thrive well among the abaca and coconut plantations.

Camarines Sur.—There is at present no regular pili plantation in any of the 32 municipalities of the province, although an aggregate area of more than 300 hectares is planted to this crop. Of the different municipalities, namely, Del Gallego, Ragay, Lupi, Sipocot, Libmanan, Cabusao, Pamplona, Pasacao, Gainza, Camaligan, Canaman, Magarao, Calabang, Tinambac, Siruma, Naga, Milaor, San Fernando, Minalabac, Pili, Bula, Tigaon, Goa, San Jose, Lagonoy, Caramoan, Sañgay, Baao, Iriga, Nabua, Bato, and Buhi, those comprising the Rinconada and Partido districts have the most pili trees although other municipalities like Libmanan, Magarao, Camaligan, Gainza, Milaor, Naga, and Calabanga have trees here and there (see map).

In the Rinconada district which is composed of the municipalities of Iriga, Buhi, Nabua, Baao, Bato, and Bula, most of the pili trees are confined to some barrios of the four first-mentioned places. In Iriga most trees are located in San Nicolas, San Agustin, San Isidro, Salvacion, San Francisco, Sto. Niño, and San Antonio; in Buhi at barrios Sagrada Familia, Lourdes, Boraboran, Tambo, and Antipolo; in Nabua, at barrios Santiago, Sto. Domingo, La Purisima, Lourdes, Antipolo, San Ramon, and Santiago (Small); in Baao, in barrios bordering the municipalities of Iriga and Nabua.

In the Partido district which is composed of the municipalities of Tigaon, Goa, San Jose, Sañgay, Caramoan, and Lagonoy only barrios Salvacion and Tinaugan of Tigaon have an appreciable number of pili trees; Sañgay, barrios Nato and Kitubay; Goa, barrios Matacla, Buyo, Masawan, and Pinaglabanan; Lagonoy, barrios Duhat, Palale, and San Rafael; San Jose, barrios Dalasan, Salogan, and Baybay.

Sorsogon.—Practically all of the municipalities of Sorsogon, namely, Bacon, Barcelona, Bulan, Bulusan, Casiguran, Castilla, Donsol, Gubat, Irosin, Juban, Magallanes, Matnog, Pilar, Prieto-Diaz, Sorsogon, and Sta. Magdalena, have pili trees. In these 16 municipalities, however, most of the pili trees are to be found either with abaca or coconut trees especially in the towns of Bacon, Barcelona, Bulusan, Donsol, Irosin, and Sorsogon (see map). Again, even in these municipalities as in other parts of the region, most trees are confined to some barrios as follows:

Bulusan: San Francisco, San Isidro, Capilihan, San Jose, and San Bernardo.
Donsol: Lomtao, Baras, Bamban, Paroras (San Jose), and San Isidro.
Irosin: Lomboon, Gabao, Monbon (at sitio Batang), Patag (at sitio Bangkó), and Bagsañgoan.
Sorsogon: Burabod, Bibingcahan, Aboyog, and Roró.
Bacon: San Juan, Maricrom, Del Rosario, Buñga, Sugod, San Roque, Balite, Sto. Domingo, and Sta. Cruz.
Barcelona: Bacabaré, Layog, and Togdon.
Prieto-Diaz: Calao and Cayo.
Gubat: Rizal.

AREA FOR PILI PLANTING

There are still fertile and wide areas of land in the four provinces of the Bicol region that are suitable for the planting of pili. Given good and steady prices, not to say assured of a steady outlet, Bicol farmers, with constant and proper information, would be willing to extend the planting of this crop. Areas, from sea level to 400 meters(3) or slightly over, suitable for the crop are still available especially in Camarines and Sorsogon.

CULTURE OF PILI IN THE REGION

Although the nut is popular among the Bicolanos and is a rare table delicacy, and although others consider it even superior to the almond, no exploratory work on or varietal studies of it have ever been undertaken. With the exception of a negligible number around school houses and in a few backyards, pili trees are

grown by chance in the region, from fallen nuts or nuts carried by birds. In fact most of the pili trees in the region are in a semi-wild state. Practically no care, whatever, is given them. They are taken as a matter of course by the Bicolanos. Hence it is that it seems the old adage "familiarity breeds contempt" applies with the Bicolanos.

In its natural habitat, pili thrives thriftily in the humid places with a more or less even distribution of rainfall. This is almost precisely the condition obtaining around Mount Iriga, Mount Isarog, Mount Mayon, Mount Bulusan, and other places where pili trees thrive well. According to Wester and substantiated by the present observations, pili trees do well at fairly low elevations—from sea level to 400 meters or slightly over, and in places where the soil is fertile and well drained. Even in clay loam soils provided these are well drained and in slightly stony places with enough soil, they have been observed to do well.

PESTS AND DISEASES

So far as is known, pili is rarely attacked by any serious pest or disease. This is borne out by testimony of people in the region and personal observations by the writer. Certain borers and fungi have been found, however, in samples of immature fallen nuts from Buhi, Camarines Sur; Mauraro, Albay; and Donsol, Sorsogon. Efforts in getting more specimens have nevertheless proven futile. For this reason, Mr. Juan de Vera, municipal agricultural inspector for southern Camarines Sur, has been requested to send specimens to the Plant Sanitation Division of the Bureau of Plant Industry.

PREPARATION OF PILI FOR MARKET

As a whole the removal of the pulp of the fruit preparatory to marketing either locally or in Manila is by scalding. The procedure is as follows:

Water is first heated in a vat or in a kerosene can to a temperature hot enough to scald the hand. Freshly gathered nuts are then immersed in the water and kept there until the pulp or husk comes off easily when pressed with the hands. At this point the fruits are removed from the water and immediately pulped by hand.

After removal of the pulp the nuts are rinsed with cool water and dried in the sun before they are packed in sacks or bags for marketing. The current price of the unprepared and prepared nuts is from 8 to 10 centavos per 100 nuts, and 6 to 8

centavos per kilo, respectively, depending upon their size, the time and place.

When the water is too hot and the fruits are left in it beyond a reasonable length of time, that is, beyond the point when the pulp gets off easily upon pressure of the hand, the husk slightly shrinks and becomes hard and difficult to remove.

Several methods of pulp removal were tried by Austria(4) as follows:

(1) By hand:
  (*a*) Crushing the pulp on a cement floor by pounding nuts with a piece of wood, taking care that the force is just enough to break the pulp but not the hard shell.
  (*b*) Scraping off the pulp with the use of knife.
(2) Retting in tap water (25°C. to 28°C.) using kerosene can containers.
(3) Placing the nuts on the ground under the shade of a tree. Ants, worms, and termites visited the place and ate part of the husk.
(4) Hot water treatments: Fruits were soaked in hot water until the husk could be removed easily. Temperatures used were 40°C., 50°C., 60°C., 70°C., and 80°C.
(5) Chemical treatments: Using 5 per cent and 10 per cent solutions of commercial potassium hydroxide (KOH) and sulfuric acid (H_2SO_4).

Austria summarized his findings as follows:

(1) Soaking the nuts in water heated to a temperature of 40°C. to 50°C. was most practical and recommendable.
(2) Below 40°C., the removal of the husk was greatly delayed.
(3) Above 50°C., the nuts in storage became rancid in a short time.
(4) At 80°C., the kernels became rancid in a month and the germs dead.
(5) At 60°C., about 50 per cent of the nuts in storage got rancid in 6 months.
(6) At 40°C., the nuts remained in good condition for a year or more.

Observations seem to show that in the removal of the pulp with hot water, in the Bicol region, the temperature used is not at all taken. The only consideration made of it is the ease with which the pulp is removed when pressed with the hand.

PAST AND PRESENT USES OF PILI

Pili is useful not only because of the fruit but also because of the tree itself. Its bark yields "brea" or Manila elemi (salong, Bicol). The word is almost as good a fuel as that of the mangrove or "bacawan" and ipil-ipil (*Leucaena glauca* L.).

Although the nuts are getting popular locally more and more, the elemi is still important in the world's market, it being used

in the manufacture of certain varnishes and various chemical ingredients of medicinal value.(5) The best buyers of this gum are the United States and Germany. In 1926, 1927, 1936, and 1937 the following constituted their importation from the Islands:(6)

	Kilos	Value
1926	312,718	₱146,284
1927	340,584	89,810
1936	240,881	59,424
1937	320,918	64,943

It is possible that in the past the Bicolanos made use of the gum (elemi) of the pili for lighting purposes, its wood for fuel, and its fruit for food. The fruit used to be eaten raw. With more knowledge on the subject, however, several preparations from the nut have been devised.

The pulp which is commonly used in many a Bicol home is, like before, eaten off-hand after scalding the fruit and after removal of the tough outermost covering. Sometimes an additional ingredient or ingredients as mentioned below are added before eating it, as:

(*a*) With a little salt.
(*b*) With a little salt and vinegar put to taste.
(*c*) With a little "balao" (Bicol term for salted very small fishes or crustaceans).
(*d*) With a little "patis" (liquid formed in the making of the balao) put to taste.

It is also sometimes used in the making of condiment although this is rarely done. In some instances an oil is extracted from the pulp and is used as olive oil and for native medicinal purposes. According to Mrs. R. Biron of Tabaco, Albay, 500 nuts would yield about $\frac{1}{4}$ liter of oil. She has given the following instructions in the extraction of the oil:

(1) Scald the ripe fruits.
(2) Express the milk from the pulp as of grated coconut.
(3) Sieve the milk with the use of a fine cloth.
(4) Let stand the liquid for some time.
(5) Take the upper portion having the oily matter and boil to evaporate the water as in making coconut oil.

As in the past the pili kernels or cotyledons are eaten off-hand raw or with other ingredients as follows:

(1) Whole kernels or after halving and removing the membraneous brownish covering the kernels are mixed with enough muscovado sugar of a thick syrupy consistency and when about ready to be put out of the fire they are made into different forms. This is almost the same process as in the making of the "Mayon" pili candies.

(2) Cotyledons mixed with dissolved refined sugar of a thick syrupy consistency as in (1) and before being made ino forms of usually one centavo a piece. These are the most common pili nut candies sold locally anywhere in the Bicol region especially at the truck station of Ligao, Albay.
(3) Mixed with grated young coconut meat and cooked with syrup.
(4) Mixed with coconut milk (expressed from mature coconuts) and then cooked with sugar. The pastry is removed from fire so that it is either in liquid or solid form.
(5) Mixed with grated "condol" (*Benincasa hispida* Cgn.) and cooked in syrup, a pastry that is very common in the Bicol region at wedding celebrations, baptismal parties and the like.
(6) Ground and mixed with other ingredients in the making of confectioneries as "turron", pudding, rolled jelly, etc. Mrs. Patricia S. Aduviso of Nabua, Camarines Sur, gave the following formulae for these pastries:

(*a*) Turron (Kendeng pili)

Pili	300 nuts
Sugar	1 kilo
Milk (condensed)	1 small can
Eggs	8
Anis	1 spoonful
Sweet potatoes	⅔ of pili
Vanilla	1 teaspoonful

Peel and cook the sweet potatoes. Mix with the pili kernels. Grind the mixture together with anis. Beat the eggs and then mix with the milk and again mix with the ground pili. Melt the sugar and after about 20 minutes add the mixtures. Wait until the desired point and then let cool. Cut to desired forms. For painting the Kendeng Pili mix little condensed milk with the yellow of the egg.

(*b*) Pudding

Mashed potatoes	2 cups
Ground pili kernels	2 cups
Refined sugar	1½ cups
Condensed milk	½ cup
Eggs	3 pieces
Butter	3 tablespoonfuls
Vanilla	1 teaspoonful

Boil potatoes until soft and peel. Mash and add the pili, sugar, butter, milk, and the well beaten eggs. Stir until smooth. Add the flavoring (vanilla) and continue stirring for a while. Put the mixture in forms, say small boxes of Manila paper. Bake in an oven with moderate heat until the color is light brown.

(*c*) Jelly Roll

Squash (mashed)	1 cup
Ground pili kernels	½ cup
Evaporated milk	½ cup
Lemon extract or vanilla	1 teaspoonful

Boil squash until soft and peel. Mash until fine. Add the pili, sugar, milk and then cook. Stir continuously until fine and smooth. Remove from fire and add the flavoring.

Pili nut is also exported to Manila where it is made into confectioneries either for local consumption or for exportation to other countries.

According to the Commerce and Industry Journal for June, 1928 the pili has been exported to the United States, France, Great Britain, and Japan in varying quantities since 1913. This was the year when pili exportation was at its peak.

Compared with that for 1937, as may be seen from the following table, not to mention the meager exportations in the intervening years it is evident that there is room for considerable improvement:

	Kilos	Value
1913	1,186,173	₱188,270
1914	296,231	44,624
1915	145,150	23,576
1916	85,907	14,434
1917	2,153	1,058
1918	489	577
1919	13,254	3,923
1920	276	161
1921	121,549	17,949
1922	27,429	4,107
1923	38,808	4,010
1924	182	64
1925	7,433	427
1926	933	179
1927	22	37
1936	47,838	9,896
1937	63,800	23,009

The causes of the decline according to the same Journal are the following:

(1) High freight charges.
(2) Limited local supply.
(3) High local prices due to competition among local confectioners.
(4) Marketing of rotten nuts.
(5) Lack of device with which to effectively crack the nuts.
(6) Poor method of removing the pulp which, if allowed to stick too long, will hasten the deterioration of the kernels.

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ILLUSTRATIONS

Plate 1

Fig. 1. A supposed late bearing pili tree, about 20 years old, at Sagrada, Buhi, Camarines Sur.
2. A nicely crowned pili tree at the edge of a fairly well cultivated abacá plantation at Agpay, Guinobatan, Albay.
3. Allegedly an ever-bearing pili tree, about 22 years old, at Buhi, Camarines Sur.
4. A pili tree, about 60 years old, used as abacá shade tree at Sorsogon.

Plate 2

Fig. 1. An uncared for pili tree, about 70 years old, used as shade tree of an equally uncared for abacá plantation at Guinobatan, Albay.
2. A pili tree in a semi-wild state, about 70 years old, used as a shade tree of abacá plants in Albay. Note the climbing vines and other growing saprophytic plants.

Plate 3

Fig. 1. Pili trees in a semi-wild state at sitio Natubigan, Bo. Agpay, Guinobatan, Albay. Pili trees marked X.
2. Allegedly a thin-shelled pili nut bearing tree located at sitio Panal, Bo. Mapaco, Guinobatan, Albay. The tree is owned by Mr. G. Orbita of Mauraro, Guinobatan.
3. Pili trees as shade trees of an abacá plantation at sitio Natubigan, Agpay, Guinobatan, Albay. Note the other tree beside the mother plant, grown from a fallen (chance) nut from the latter. Many trees in the Bicol region are of such origin.

Plate 4

Fig. 1. A luxuriant pili tree growing in between coconut trees.

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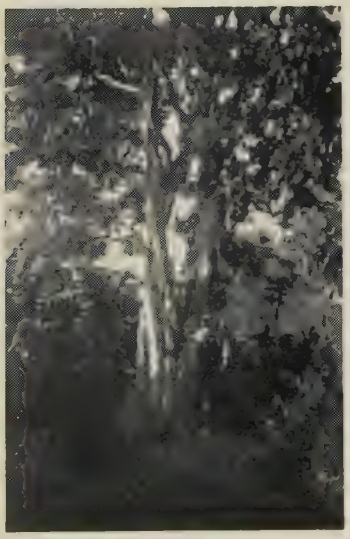

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PLATE 1.

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PLATE 2.

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PLATE 3.

PLATE 4.

THE GRANJA SUGAR CANE EXPERIMENT STATION

By JUAN B. CABANOS

Former Superintendent, G.S.C.E.S., Bureau of Plant Industry

TWENTY-THREE PLATES

FOREWORD

The Granja Sugar Cane Experiment Station was the best developed and certainly the most profitable experiment station of the Bureau of Plant Industry. After 36 years of continuous operation under government management it passed hands last year (1938) to a new management, the Agricultural Service, Inc., (with head office at Manila) which acquired the station under a contract of lease. The operation of the station by the Government having been closed by virtue of this lease, an attempt is hereby made for purposes of record, to review brefly its past activities and salient accomplishments during the time it was run as a government institution. Institutions, like men, are judged by their achievements.

Using, therefore, a semblance of a yardstick to measure its accomplishments, the following questions present themselves: How far did the Granja approach the objectives for which it was established as an experiment station? What definite and tangible accomplishments has it contributed for the benefit of the farmers? What contribution did it make in the economic betterment of the country? Has it justified its existence as an experiment station for agricultural leadership?

The following paper, presented succinctly and as comprehensively as possible, is an honest and conservative appraisal of the work the Granja has done in attempting to answer the above questions, and can best be evaluated by the kind of contribution it has rendered in helping to improve Philippine agriculture.

HISTORY

The Granja Sugar Cane Experiment Station, known during the Spanish times as "La Granja Modelo" was established as a Spanish Garden by the Spanish Government about the year 1890.

The farm as such was kept in operation up to 1896. With the insurrection that year, it was taken over by the Negros Independent Government. In 1900 when the American Military authorities took charge of the Island of Negros, the farm passed hands again, this time as a military post known as Camp Barrett, during the Provisional Military Government. A portion of the station still retains the name Camp Barrett. In 1901 the farm was transferred to the Central Government and a year later (in 1902) it was turned over to the then newly established Insular Bureau of Agriculture for operation. The actual occupation of the farm under the new office began on April 22, 1903. At that time, the farm was in poor condition, the work having been abandoned during the insurrection. The remnants of the Spanish workings found in the place were a sugar mill, little plantings of coffee, cacao, abaca, beetlenuts, and farm implements and a few head of carabaos. The houses and growing crops were burned in 1899 by the Insurgents.

With the limited facilities found on the farm left out of the ruins of the revolution, work was resumed with attention directed in the main to sugar-cane culture, especially experiments and tests on the comparative merits of sugar-cane varieties. Fixing the premises in shape, clearing and transplanting the abandoned coffee, cacao, and abacá seedlings, trial plantings of seeds and plant materials sent by the Bureau to the station, erecting temporary quarters, building roads, and performing such other urgent and necessary work for its proper operation, all these were attended to. Thus, the work in the farm gradually picked up from year to year with semi-commercial production of sugar and the cultures of introduced cane varieties from abroad as the principal projects. In 1907 the commercial production of sugar cane was discontinued, only to be resumed in 1909; and during the suspension of commercial planting, the Bureau went into general experimental trials, and tests with sugar cane and other crops, such as abacá, maguey, corn, sweet potatoes, forage, and leguminous plants. At this time a number of mares, stallions, and Indian cattle were sent to the station with the idea of incorporating animal husbandry alongside the work of the station.

From 1910 on, the activities of the station in plant and livestock propagation and distribution not only gradually increased in volume but also gradually veered from experimental to commercial production.

In 1930, by virtue of Act No. 3639 splitting the Bureau of Agriculture into two bureaus, the Bureaus of Animal Industry and Plant Industry, the station land was divided accordingly, assigning to each Bureau its respective activities.

LAND

Location.—The Granja Sugar Cane Experiment Station is located at La Granja, La Carlota, Occidental Negros. La Granja is a barrio of La Carlota, 8 kilometers away from the town. It is about 54 kilometers from Bacolod and 33 kilometers from Pulupandan, the seaport of the province. The station is passed through by the La Carlota-La Castellana provincial road, a fact which renders it easily accessible by car and regular transportation facilities.

Area and its distribution.—The total area of this government land is 604.3124 hectares apportioned between two Bureaus as follows:

	Hectares
Granja Sugar Cane Experiment Station of the Bureau of Plant Industry	496.3124
La Carlota Stock Farm of the Bureau of Animal Industry	108.0000
Total	604.3124

The area of 496.3124 hectares belonging to the Granja Sugar Cane Experiment Station was, at the time the lease was effected, all under cultivation both by the administration and by its eight sugar-cane tenants as follows:

	Hectares
By the station:	
Field area for commercial plantings, experimental cultures, etc.	91.0000
Field area occupied by buildings, lawns, barrio obrero, nursery, orchards, pasture roads, building premises and other cultures	75.9124
School site	1.0000
By the sugar-cane tenants:	
Doroteo Jalandoni	56.0000
Luis Jalandoni	39.0000
Julia Managuit	48.8000
Rosa Jereza	6.6000
Santiago Maguad	25.0000
Baldomero Meana	72.0000
Manuel Gepanago	33.0000
Florencia Tad-Y	48.0000
Total	496.3124

Soil and climate.—The station is situated at the foot of Mount Kanlaon, with an altitude of about 107 meters above sea level. The general topography of the land is one which slopes gently from the east portion westward. The southwest portion of the entire reservation, however, is level with fertile, light loamy soil of volcanic origin. The depth of the surface soil varies from 30 centimeters to over 90 centimeters underlaid for the most part with drift boulders, gravel, and adobe rock. Because of its good topography, drainage is no problem. The general condition of the soil is excellent for all-round tropical agriculture.

The climate is also ideal for agriculture, the rainfall being fairly well distributed during the year. Usually the rain begins early in April and lasts till December. Dry months are January, February, and March but even in these months, there are occasional showers beneficial to the growing of annual and short growing crops.

This west Negros district is well beyond the typhoon belt and therefore, is free from the hazards of floods and destructive typhoons.

The rainfall and meteorological observation readings taken at the station in the last four years follow:

Year	Rainfall			Temperature O°			Relative humidity %		
	Number of rainy days	Average daily rainfall (inches)	Total (Inches)	Minimum (Average)	Maximum (Average)	Mean (Average)	Minimum (Average)	Maximum (Average)	Average
1935	120	0.268	72.69	16.2	37.4	22.0	53	86	75
1936	132	0.368	17.13	18.7	33.4	24.3	57	96	82
1937	147	0.336	9.79	20.5	33.2	26.5	57	96	82
1938	107	0.272	49.65	20.2	34.6	26.6	49	98	82

NOTE.—The 1935 record is for 9 months, that of 1938 is for 6 months, those of 1936 and 1937 are for all months except December.

Sugar quota of the government land.—With the advent of sugar limitation during the 1933–34 crop year the station's commercial sugar-cane area was allotted a quota of 14,134 piculs. Of this sugar quota, the station proper was allotted 4,228 piculs while the eight sugar-cane tenants of the station apportioned among themselves the rest or 9,906 piculs. The milling participation of the station and its tenants from the La Carlota Sugar Central is on the 55–45 basis; that is, 55 per cent for the station and 45 per cent for the Central. At this rate of participation (for the non-adhered planters as the station) and with the 12

per cent rate of rent derived from the tenants from their total quota paid to the Bureau, the station used to get annually the following sugar:

	Piculs
Exportable sugar	3,089.52
Local consumption sugar	266.82
Reserve sugar	157.89

ORGANIZATION AND PERSONNEL

The organization of the station literally bristles with varied reminiscences of both the Spanish, Negros Republic, and American régimes. Under the Spanish tutelage, the station was under the management of Don Jose Sanchez, a soil physicist. During the Negros Independent Government, the farm was managed by Mr. Francisco Perez, who was later relieved by Mr. Santiago Morales. When the military authorities took charge of Negros Island, Mr. Juan Araneta was appointed manager of the farm in representation of the United States Government, until it was transferred to the Central Government when Mr. A. P. Hyne, an American, was appointed as first Station Superintendent in 1902.

From that time on, in the lapse of 36 years, the station had the following superintendents:

Mr. A. P. Hyne	1902–1903
Mr. John Heil	1904–1905
Mr. H. J. Gallagher	1905–1908
Mr. F. E. Deason Mr. R. E. Burris	1909
Mr. H. J. Gallagher	1910–1914
Mr. J. McNamara	1915
Mr. M. Manas y Cruz	1916–1917
Mr. O. Soriano	1918
Mr. F. D. Marquez	1919–1923
Mr. S. Asuncion	1923–1926
Mr. A. Labrador Mr. P. A. Villyar (Acting)	1926–1927
Mr. F. D. Maramba	1928–1932
Mr. P. A. Honrado	1933–1934
Mr. J. B. Cabanos	1935–1938

Throughout all the years of operation of the station, these superintendents had their technical assistants and sufficient labor force to help them carry out the administration work and the tasks entailed by the different experimental and commercial projects of the station.

Tenants, tenancy, and population of the reservation.—In addition to the eight sugar-cane tenants of the station, there are small tenants on corn and rice living in the Government Reservation. The area cultivated by each family ranges from a hectare to two hectares. The rate of rental charged is from one-fourth to one-third of the crops depending on the fertility of the land. Aside from their activities as tenants of the station, they are now and then employed by the administration during busy days on the farm either on the basis of the piece work system, or the daily wage. It may be added in passing that the living conditions of the tenants of the station are comparatively more enhanced than the lot of the laborers and tenants in the average haciendas around La Granja.

A census of the population and other pertinent data of the station at the time the transfer was made are as follows:

	Barrios of—			Pasture lot converted for cultivation	Total
	La Granja	Pampang Suba	Pinamonan		
Area of homelots from 100 to 5,000 sq. m.	[a] 2.1075	[a] 1.2775	[a] 3.8025	[a] 0.5730	[a] 7.7605
Number of houses	39	19	32	9	99
Number of families	57	21	37	11	116
Population	283	94	151	44	574
Years of residence	[b] 1–35	[b] 6–20	[b] 1½–75	[b] 1–3	[b] 1–75
Station tenants	37	18	27	11	93
Station laborers	20	3	----------	1	24
Station laborers "Paquiao"	47	23	8	9	87
Rice and corn land cultivated	[a] 43.61	[a] 12.7	[a] 28.02	[a] 12.15	[a] 96.48

[a] Hectares. [b] Years.

ACTIVITIES AND ACCOMPLISHMENTS

A. Plant Industries

1. *Plant introductions, experiments, commercial planting, etc.*

(*a*) *Sugar cane.*—The Granja Sugar Cane Experiment Station was primarily established to serve the sugar industry of the Philippines. This station performed distinct service to the sugar industry as may be gleaned hereunder.

The work on introduction of sugar-cane varieties and their trials and tests at the station began in 1905. From time to time, thereafter, until 1930, many introductions and trial tests were made of such imported cane varieties as seemed desirable, from well-known sugar districts of the world at the station with a view to determining the best adapted varieties that would give

higher yields than those existing in the Philippines. In like manner, native varieties were tested with the idea of discarding those falling below standard.

The countries of origin, names, and years of introduction of these varieties are as follows:

P. I. number	Variety	Year introduced	Origin
8386	White Bamboo	1905	Hawaiian Sugar Planters' Association.
8769	Louisiana Purple	1905	Do.
4019	Demerara No. 74	1905	Do.
4020	Singapore Striped	1905	Do.
8753	Hawaii No. 16	1910	Do.
8754	Hawaii No. 20	1910	Do.
8755	Hawaii No. 27	1910	Do.
8756	Hawaii No. 69	1910	Do.
8758	Hawaii No. 227	1910	Do.
8759	Hawaii No. 309	1910	Do.
4019-A	Demerara No. 74	1910	Do.
4019 B	Demerara No. 117	1910	Do.
8748	Demerara No. 1135	1910	Do.
8751	H-109	1910	Do.
8770	Louisiana Striped	1911	Louisiana Sugar Experiment Station, U. S. A.
8812	Louisiana Purple	1911	Do.
8779	Yellow Caledonia	1911	Hawaiian Sugar Planters' Association.
4019-C	Demerara No. 74	1911	Louisiana Sugar Experiment Station, U. S. A.
8747	Demerara No. 95	1911	Do.
8764	Lahaina	1911	Honolulu, Hawaii.
8760	Cheribon Imperial Striped	1912	Australia.
8772	Malagache	1912	Do.
9850	Mauritius 1900	1912	Do.
8771	Malabar	1912	Do.
8811	White Bamboo	1912	Do.
8750	New Guinea No. 24	1912	Do.
8775	New Guinea No. 24-A	1912	Do.
8776	New Guinea No. 24-B	1912	Do.
8744	Barbados No. 3141	1912	Do.
8757	Hawaii No. 109	1912	Honolulu, Hawaii.
8763	Java 247	1912	Java.
10079	Chinois	1913	Saigon, Indo-China.
10078	Big Tanna	1913	Do.
8771	Malabar	1913	Australia.
8744	Barbados	1913	Do.
8752	Hambledon No. 5	1913	Do.
8777	New Guinea No. 40	1913	Do.
8775	New Guinea No. 24-A	1913	Do.
8776	New Guinea No. 24 B	1913	Do.
8743	Badila	1913	Do.
9328	P. O. J. 100	1915	Sugar Experiment Station, Pasoeroean, Java.
8603	P. O. J. 213	1915	Do.
4925	P. O. J. 2727	1915	Do.
4021	P. O. J. 826	1915	Do.

P. I. number	Variety	Year introduced	Origin
4022	P. O. J. 979	1915	Sugar Experiment Station, Pasoeroean, Java.
8746	Black Cheribon	1915	Do.
9328	P. O. J. 100	1916	Sugar Experiment Station, Pasoeroean, Java.
8817	P. O. J. 213	1916	Do.
4021-A	P. O. J. 826	1916	Do.
4022-A	P. O. J. 979	1916	Do.
4023	P. O. J. 1499	1916	Do.
4024	P. O. J. 1507	1916	Do.
4025	P. O. J. 2542	1916	Do.
9031	E. K. 2	1916	Do.
9032	D. I. 52	1916	Do.
4025	B 247	1916	Do.
8746-A	Black Cheribon	1916	Do.
4026	Java No. 36	1916	Formosa, Japan.
4027	Java No. 105	1916	Do.
8762	Java No. 213	1916	Do.
4028	Demerara No. 247	1917	Santiago Experiment Station, Cuba.
4029	Demerara No. 604	1917	Do.
4030	Demerara No. 625	1917	Do.
4031	Barbados No. 208	1917	Santiago Experiment Station, Cuba.
4032	Barbados No. 306	1917	Do.
4033	Barbados No. 1753	1917	Do.
4034	Barbados No. 3412	1917	Do.
4035	Barbados No. 6204	1917	Do.
4036	Barbados No. 6308	1917	Do.
4037	Barbados No. 6450	1917	Do.
4038	Lucier White	1917	Do.
10365	Barbados 147	1919	Proefstation, Pasoeroean, Java.
8546	Mia Lao	1924	Saigon, Indo-China.
9031	E. K. 2	1925	Pasoeroean, Java.
9032	D. I. 52	1925	Do.
9033	S. W. 3	1925	Do.
9090	B. H. 10/12	1925	San Juan, Porto Rico.
9171	Malayan Striped No. 7	1926	Kuala Lumpur, F. M. S.
9171-A	Malayan Striped No. 8	1926	Do.
9171-B	Malayan Striped No. 9	1926	Do.
9327	P. O. J. 36	1926	Pasoeroean, Java.
9328	P .O. J. 105	1926	Do.
9329	P. O. J. 213	1926	Do.
9330	P. O. J. 234	1926	Do.
9331	P. O. J. 279	1926	Do.
9332	Striped Preanger	1926	Do.
9472	CO. 205	1927	Pusa, Bihar, India.
9473	CO. 210	1927	Do.
9474	CO. 213	1927	Do.
9475	CO. 214	1927	Do.
9476	CO. 281	1927	Do.
4910	P. O. J. 2878	1927	Iloilo.
4926	P. O. J. 2883	1927	Do.
4924	Khari	1928	Java.
10366	DI 52	1928	Do.
9775	Khari	1928	South India.
9033	P. O. J.	1929	Pasoeroean, Java.
10408	Cross No. 1507	1931	Honolulu, Hawaii.

P. I. number	Variety	Year introduced	Origin
10409	B. H. 11569	1931	Honolulu, Hawaii.
10410	Pentwen	1931	Do.
10499	Mia Lao	1931	Saigon, Indo-China.
10500	Mia Lao Tiem	1931	Do.
12390	C. P. 27-108	1932	Florida, U. S. A.
12391	F-29-7	1932	Do.
11633	Mayaguez 42	1933	Washington, D. C., U. S. A.
11444	P. O. J. 2346	1933	Pasoeroean, Java.
11620	Mayaguez 3	1933	Washington, D. C., U. S. A.
11621	Mayaguez 7	1933	Do.
11443	P. O. J. 2725	1933	Pasoeroean, Java.
13185	P. O. J. 2961	1933	Do.
15320	P. O. J. 2961	1933	Do.

In the process of repeated trials and experimentations with these canes, the varieties which were found to be desirable were multiplied for distribution to the public. Other stations of the Bureau coöperated in the rapid propagation of recommended canes to supply the increasing demand for stock materials. The Granja Sugar Cane Experiment Station laid capital stress on the selection, propagation, and dissemination of the good varieties of sugar cane throughout the Philippines. For about 25 years, from 1905 to 1930, the station carried on the above activities, thus gradually eliminating the old, poor native canes by supplanting them with superior varieties. It is a matter of common knowledge among the sugar-cane planters that in the period from 1915 to 1930, such varieties as Hawaii Nos. 16, 20, 27, 69, 109 and others; the New Guinea, Nos. 15 (Badila), 24, 24–A, and 24–B; Barbados 147; Mauritius 1900; Java 247; Lahaina; Yellow Caledonia; the DI–52; Louisiana Striped; Negros Purple; Luzon White and Cebu Purple became very popular all over the Islands. Some of these varieties like the Badila, DI–52 and P. O. J. varieties maintained their popularity in Negros while the rest were either supplanted or replaced by new varieties like the Alunan and the P. S. A. 14.

In the distribution of cane cuttings and points secured from these good varieties, the records of the station from 1921 to 1938 are tabulated in Table 1 where it will be noted that the range of distribution was all over the sugar producing provinces of the Islands, and some foreign countries to which cuttings and points were sent in exchange.

TABLE No. 1.—*Showing the distribution of sugar cane points and cuttings at the Granja Sugar Cane Experiment Station from 1921 to 1938*

Varieties	Years					
	1921	1922	1923	1924	1925	1926
1. Badila	365	1,194	41,550	67,397	148,853	189,967
2. Barbados	228	337	900	3,142	7,600	75,670
3. Big Tana	370	233	800	2,625	700	100
4. Cebu Purple	154		5,510	5,100	9,503	18,000
5. Cheribon	17			10		
6. Chinois	102					
7. Demerara 95	6		300			
8. D-1135	1,203		2,000	100		
9. Formosa	3					
10. Guro or N. G.-24	537	120	5,400	11,946	2,550	36,550
11. Hambledon	3					
12. H-16	1,124					
13. H-20	725					
14. H-27	686	4	152			
15. H-227	1,528					
16. H-309	23					
17. Imperial Striped	3			6		
18. Ina Iman	333			3		2
19. Java-213	210	720				
20. Java-247	605	342	3,300	8,300	2,900	67,775
21. Lahaina	654					
22. Luzon No. 1	9	4	24	20	3	500
23. Luzon No. 2	187	276	1,002	3,700	3	1,505
24. Luzon No. 3	3	6	3,020	600		
25. Luzon No. 4	3	4	502			
26. H-109	2,000		9,700	11,515	13,600	59,700
27. Louisiana Purple	15			6		
28. Louisiana Striped	409	50	410	6,006	3,000	
29. Malabar	23	112	500			
30. Malagache	31			6		
31. Mindoro	2					
32. Negros Purple	326	1,032	15,600	54,645	23,003	119,025
33. New Guinea 24-A	3		2,200	10,596	16,425	97,314
34. New Guinea 24-B	154	176	2,500	8,445	3,475	28,425
35. Otomato	4					
36. Tigbao Mestiza	9					
37. Uba	9	7,094.4		10,200		
38. Yellow Caledonia	2,109	5,094	20,404	25,900	35,200	14,650
39. P. S. A. 14						
40. D1-52						
41. Rose Bamboo						7,000
42. P. O. J. 2878						
43. P. O. J. 2883						
44. P. B.-118						
45. Mauritius						
46. L. C. 28/1						
47. L. C. 22/4						2,715
48. L. C. 25/191 or Alunan						
49. L. C. 26/82						
50. L. C. 21/2						
51. L. C. 25/134						
52. L. C. 35/432						
53. L. C. 25/284						
54. L. C. 25/424						

TABLE No. 1.—*Showing the distribution of sugar cane, etc.*—Ctd.

Varieties	Years					
	1921	1922	1923	1924	1925	1926
55. L. C. 25/329						
56. L. C. 25/347						
57. L. C. 25/777						
58. L. C. 25/326						
59. L. C. 25/338						
60. L. C. 25/459						
61. H. Q. 429						
62. L. C. 25/229						
63. L. C. 25/210						
64. H. Q. 426						10
65. New Guinea–40	69	176		6		
66. B. H. Q. 10/12						
67. L. C. 20/422						
68. L. C. 25/224						
Totals	14,244	16,974	115,778	230,274	226,815	718,908

Varieties	Years					
	1927	1928	1929	1930	1931	1932
1. Badila	136,980	78,600	32,015	2,496		
2. Barbados	24,470	26,154	1,000			
3. Big Tana						
4. Cebu Purple	2,000	1,000				
5. Cheribon						
6. Chinois						
7. Demerara 95						
8. D–1135	50	12				
9. Formosa						
10. Guro or N. G.–24	25,677	4,034				
11. Hambledon		34,700	5,033			
12. H–16		5				
13. H–20		5				
14. H–27		5				
15. H–227						
16. H–309		5				
17. Imperial Striped						
18. Ina Iman						
19. Java–213	102					
20. Java–247	25,225	29,580	11,640	1,000		
21. Lahaina						
22. Luzon No. 1	1,000	400				
23. Luzon No. 2						
24. Luzon No. 3						
25. Luzon No. 4						
26. H–109	108,910	18,312	16,060	200		
27. Louisiana Purple	3,507					
28. Louisiana Striped		2,600				
29. Malabar						
30. Malagache	2					
31. Mindoro						
32. Negros Purple		450	3,500			
33. New Guinea 24–A	372,789	67,350	17,484	2,046		
34. New Guinea 24–B	13,727	15,700				
35. Otomato						

TABLE NO. 1.—*Showing the distribution of sugar cane, etc.*—Ctd.

Varieties	Years					
	1927	1928	1929	1930	1931	1932
36. Tigbao Mestiza						
37. Uba	5,800					
38. Yellow Caledonia	44,380	13,590	500			
39. P. S. A. 14						
40. D1–52		53	4,716	262		
41. Rose Bamboo	16,900	4,400	50			
42. P. O. J. 2878	6	34	308	981		
43. P. O. J. 2883						
44. P. B.–118		10				
45. Mauritius	2	500	10			
46. L. C. 28/1			10	10		
47. L. C. 22/4	12,887	5,857	9,800	12		
48. L. C. 25/191 or Alunan	5,000	80,000	172,244	329,321	914,100	285,600
49. L. C. 26/82			8	10		
50. L. C. 21/2	10			10		
51. L. C. 25/134	10					
52. L. C. 35/432		10				
53. L. C. 25/284	6					
54. L. C. 25/424	12					
55. L. C. 25/329	11					
56. L. C. 25/347	6					
57. L. C. 25/777	23					
58. L. C. 25/326	54					
59. L. C. 25/338	6					
60. L. C. 25/459	12					
61. H. Q. 429	3,052	1,000	1,026	10		
62. L. C. 25/229		25				
63. L. C. 25/210		20				
64. H. Q. 426	48,709	12,027	600			
65. New Guinea–40						
66. B. H. Q. 10/12			10			
67. L. C. 20/422			10			
68. L. C. 25/224			70			
Totals	851,324	396,438	276,324	336,358	914,100	285,600

Varieties	Years					
	1933	1934	1935	1936	1937	1938
1. Badila					48,400	6
2. Barbados					25	6
3. Big Tana						
4. Cebu Purple						
5. Cheribon						
6. Chinois						
7. Demerara 95						
8. D–1135						
9. Formosa						
10. Guro or N. G.–24						
11. Hambledon						
12. H–16						
13. H–20						
14. H–27						
15. H–227						

TABLE No. 1.—*Showing the distribution of sugar cane, etc.*—Ctd.

Varieties	Years					
	1933	1934	1935	1936	1937	1938
16. H-309						
17. Imperial Striped						
18. Ina Iman						
19. Java-213						
20. Java-247					6	
21. Lahaina						
22. Luzon No. 1						
23. Luzon No. 2						
24. Luzon No. 3						
25. Luzon No. 4						
26. H-109						
27. Louisiana Purple						
28. Louisiana Striped						
29. Malabar						
30. Malagache						
31. Mindoro						
32. Negros Purple						
33. New Guinea 24-A						
34. New Guinea 24-B						
35. Otomato						
36. Tigbao Mestiza						
37. Uba						
38. Yellow Caledonia						
39. P. S. A. 14					20,000	6
40. D1-52					700	6
41. Rose Bamboo						
42. P. O. J. 2878						
43. P. O. J. 2883					24	6
44. P. B.-118						
45. Mauritius						
46. L. C. 28/1						
47. L. C. 22/4						
48. L. C. 25/191 or Alunan	168,900	483,000	5,000	594,000	402,100	400
49. L. C. 26/82						
50. L. C. 21/2						
51. L. C. 25/134						
52. L. C. 35/432						
53. L. C. 25/284						
54. L. C. 25/424						
55. L. C. 25/329						
56. L. C. 25/347						
57. L. C. 25/777						
58. L. C. 25/326						
59. L. C. 25/338						
60. L. C. 25/459						
61. H. Q. 429						
62. L. C. 25/229						
63. L. C. 25/210						
64. H. Q. 426						
65. New Guinea-40						
66. B. H. Q. 10/12						
67. L. C. 20/422						
68. L. C. 25/224						
Totals	168,900	483,000	5,000	594,000	471,471	340

NOTE:

Distributed to 138 parties (in 1921 at Central Office) in Pampanga, Laguna, Batangas, Occidental Negros, Australia, Argentine Republic, Japan, and Nueva Ecija.

Distributed to 34 parties (in 1922 at Central Office) in Pampanga, Nueva Ecija, Laguna, Occidental Negros, and Brisbane, Australia.

Distributed to 179 parties (in 1923 at Central Office) in Pampanga, Laguna, Batangas, Tarlac, Nueva Ecija, Occidental Negros, Oriental Negros, Iloilo, Isabela and Ilocos.

Distributed to 221 parties (in 1924 at Central Office) in Pampanga, Laguna, Batangas, Tarlac, Nueva Ecija, Occidental Negros, Oriental Negros, Iloilo, Isabela, Japan, Argentine Republic, Australia and Ilocos.

Distributed to 193 parties (in 1925 at Central Office) in Pampanga, Laguna, Batangas, Tarlac, Nueva Ecija, Occidental Negros, Oriental Negros, Iloilo, Isabela, and Australia.

Distributed to 488 parties (in 1926 at Central Office) in Pampanga, Laguna, Batangas, Tarlac, Nueva Ecija, Occidental Negros, Oriental Negros, Iloilo and Australia.

Distributed to 550 parties (in 1927 at Central Office) in Pampanga, Laguna, Batangas, Tarlac, Nueva Ecija, Occidental Negros, Oriental Negros, Iloilo, Isabela, Ilocos, Bulacan, Rizal, Australia and Japan.

Distributed to 385 parties (in 1928 at Central Office) in Pampanga, Laguna, Batangas, Tarlac, Nueva Ecija, Occidental Negros, Oriental Negros and Iloilo.

Distributed to 388 parties (in 1929 at Central Office) in Pampanga, Laguna, Batangas, Tarlac, Nueva Ecija, Occidental Negros, Oriental Negros, Iloilo, Australia and Ilocos.

Distributed to 66 parties (in 1930 at Central Office) in Pampanga, Laguna, Occidental Negros, Iloilo and Rizal.

Distributed to 12 parties (in 1937 at Central Office) in Occidental Negros and Lanao.

Distributed to 3 parties in 1938 in Oriental Negros, Romblon and Hawaii.

The data on the distributions of the Alunan cane from 1931 to and including 1936, were taken from the article entitled "The Alunan Cane", by "Lanuza and Cruz", Phil. Agri. Rev., Vol. 8, No. 3, 1937, page 314.

Aside from the sugar-cane variety and acclimatization tests the important tests were those on the uses of fertilizers, milling, distance of planting, irrigation, deep versus shallow plowing, hilling, trash thinning versus burning, double versus single points planting, and non-defoliation. Studies on pests and diseases and other cultural and crop rotation experiments were also conducted.

Results derived from these experimentations were extended to sugar planters by demonstration, coöperative work, and other allied extension activities.

The benefits derived from these experiments and extension activities may be summarized by saying that the variety tests and analyses of varieties made possible the elimination of undesirable varieties; the milling tests, the improved manufacture of sugar; the extension work in the propagation of the best cane varieties, better cultural methods, and more effective control of pests and diseases. All these results were instrumental in safeguarding the investment of money and making the sugar business highly profitable.

Mention is also made here of the sugar laboratory work of the station the services of which farmers of the district availed themselves of free of charge. Before the milling season the

station received samples of their canes for analysis. This work was popular among the planters as the analyses made of the canes determined the right milling time.

An important phase of the sugar-cane work of the station was cane breeding. The cane hybridization work had many objects aimed at but the most important was the production of strains superior to the then existing varieties. The first attempt at hybridization was made during the 1921–1922 sugar-cane season. Yearly crosses were made thereafter but the last batch of seedlings trace their origin from the 1931 and 1932 crops.

Records of the station show that thousands and thousands of seedlings were produced, cultured, and studied but only one seedling strain from the cross between the New Guinea No. 15 (Badila) and the Java 247 stood the rigid test of selection. This strain is now called the famous L. C. 25/191 or the Alunan cane[1], a distinct and valuable contribution of the Granja Sugar Cane Experiment Station to the sugar industry, produced by the late Anselmo Labrador and named in honor of the then Secretary of Agriculture and Natural Resources, Hon. Rafael R. Alunan, one of those preeminently connected with the sugar industry.[2]

The station had under culture at the time it was turned over to Agricultural Service, Inc., seedling canes of the varieties enumerated in Table 2. These seedlings came from the 1931 and 1932 crosses, with the exception of L. C. 25/190, L. C. 25/130, and L. C. 30/100 which were from the 1925 and 1930 crosses. A number of these seedlings (see Table 2) are of great promise, especially the following:

L. C. 25/190	L. C. 30/100
L. C. 25/310	L. C. 31/14
L. C. 31/530	L. C. 31/1551
L. C. 31/265	L. C. 31/20
L. C. 31/13	L. C. 31/1521
L. C. 31/1460	L. C. 31/262
L. C. 31/263	L. C. 31/347
L. C. 31/1501	L. C. 31/1398

After a series of strain tests made of these hybrid seedlings, it was found that L. C. 25/190, another selection from the cross

[1] See Lanuza and Manas Cruz. The Alunan Cane in the Sugar Industry of Negros. Phil. Journal of Agri., Vol. 8 (1937), pp. 311–325.

[2] L. C. stands for La Carlota; figure *25* stands for 1925, the year when the cross was made; 191 stands for the serial number of the seedling.

between Java 247 and Badila which gave rise to the well-known Alunan, and L. C. 30/100 seedlings from the cross between P. O. J. 2878 and P. B. 119 are as good as the Alunan itself. To differentiate these strains from the Alunan, or other cane varieties, I propose to name the L. C. 25/190 strain as the "Labrador" cane as posthumous honor to its originator and the L. C. 30/100 strain as the "La Granja" cane in honor of the station, for its pioneering leadership in the promotion of the Philippine sugar industry and as a fitting memento of the meaning of its name aptly given by the Spaniards and which it maintained during the 48 years of its operation as a government institution.

TABLE No. 2.—*Seedling canes at Granja Sugar Cane Experiment Station under 1938 culture.*

Variety or strain No.	Parentage ♀ × ♂	Analysis			
		1935–36 crop		1936–37 crop	
		Suc. (11	P–T mos.)	Suc. (10	P–T mos.)
L. C. 31/14	DI–52 x Bukidnon	18.84	2.26	15.96	1.92
L. C. 31/530	H–109 x LCTR	19.20	2.21	14.68	1.65
L. C. 31/766	H–109 x LCTR				
L. C. 31/563	do			19.85	
L. C. 31/1551	LC 25/191 x Barbados 147	19.32	2.35	16.75	2.04
L. C. 31/265	H–109 x LCTR	19.54	2.18	16.58	1.92
L. C. 31/225	POJ 2883 x LCTW				
L. C. 31/20	DI–52 x Bukidnon Tig	17.23	2.27	15.77	1.83
L. C. 31/13	do	17.99	2.21	16.03	1.97
L. C. 31/800	H–109 x LCTR				
L. C. 31/296	do	12.79	1.34	14.86	1.72
L. C. 31/3	DI–52 x Bukidnon	16.46	1.94	13.78	1.60
L. C. 31/672	H–109 x LCTR	15.74	1.81	16.26	1.95
L. C. 31/1521	B. 147 x Badila	16.25	1.93	16.59	1.92
L. C. 31/1460	Badila x Barbados 147	14.62	1.62	15.59	1.98
L. C. 31/327	DI–52 x LCTW	17.89	2.18	15.21	1.76
L. C. 31/262	do	19.15	2.27	17.06	2.16
L. C. 31/263	do	20.58	2.59	19.21	2.40
L. C. 31/347	Badila x Barbados 147	19.56	2.09	19.31	2.39
L. C. 31/1421	do	18.85	2.29	13.20	1.47
L. C. 31/1103	Barbados 147 x LCTY	17.73	2.05	16.19	1.85
L. C. 31/1501	Barbados 147 x Badila	19.26	2.38	19.22	2.36
L. C. 31/1483	do	19.17	2.14	16.77	1.87
L. C. 31/1398	Barbados 147 x LCTY	16.68	1.87	17.47	2.11
L. C. 31/13	DI–52 x Bukidnon	17.95	2.01	17.41	2.09
L. C. 31/1621	Java 247 x LCTR	14.80	1.61	14.10	1.56
L. C. 31/1130	Badila x Barbados 147	16.86	1.92	14.56	1.66
L. C. 31/100	POJ 2878 x PB 119	15.49	1.55	18.92	2.31
L. C. 31/190	J. 247 x Badila	15.69	1.66	18.44	2.27
L. C. 31/73	POJ 2882 x LCTW			15.64	
L. C. 31/535	H–109 x LCTR			17.35	
L. C. 31/1158	do				
L. C. 31/306	DI–52 x LCTW			14.09	
L. C. 31/249	N. Purple x LCTW			17.34	

NOTE:
LCTR—La Carlota Tigbao Red.
LCTW—La Carlota Tigbao White.
LCTY—La Carlota Tigbao Yellow.

TABLE No. 2.—*Seedling canes at Granja Sugar Cane Experiment Station under 1938 culture.*—Continued

Variety or strain No.	Parentage ♀ + x ♂	Analysis			
		1935-36 crop		1936-37 crop	
		Suc. (11	P-T mos.)	Suc. (10	P-T mos.)
L. C. 31/355	DI-52 x Encar				
L. C. 31/310	DI-52 x LCTW				
L. C. 31/18	DI-52 x Bukidnon				
L. C. 31/1479	Badila x POJ 2878				
L. C. 31/1321	POJ 2878 x LCTW				
L. C. 31/1440	Badila x Barbados 147				
L. C. 31/1419	Barbados 147 x LCTY				
L. C. 31/615	H-109 x LCTR				
L. C. 31/383	do				
L. C. 31/1381	Barbados 147 x LCTY				
L. C. 31/302	DI-52 x LCTW				
L. C. 31/337	DI-52 x Encar				
L. C. 31/387	H-109 x LCTR				
L. C. 31/272	DI-52 x LCTW				
L. C. 31/319	do				
L. C. 31/314	H-109 x LCTR				
L. C. 31/138	POJ 2883 x LCTW				
L. C. 31/1573	Barbados 147 x LC 25/191				
L. C. 31/1402	Barbados 147 x LCTY				
L. C. 31/1557	LC 25/191 x Barbados 147				
L. C. 31/ 140	POJ 2883 x LCTW				
L. C. 31/1372	Badila x Barbados 147				
L. C. 31/1387	Barbados 147 x LCTY				
L. C. 31/1401	do				
L. C. 31/1157	H-109 x LCTR				
L. C. 31/928	do				
L. C. 31/1385	Barbados 147 x LCTY				
L. C. 25/310	J. 247 x Badila				
L. C. 32	Parentage unknown				
L. C. 32	do			17.46	
L. C. 32	do			16.45	
L. C. 32	do			15.77	
L. C. 32	do			21.05	
L. C. 32	do			17.85	
L. C. 32	do			18.84	
L. C. 32	do			19.79	
L. C. 32	do				
L. C. 32	do			13.96	
L. C. 32	do			17.97	
L. C. 32	do			18.06	

NOTE:

LCTW—La Carlota Tigbao White.
LCTY—La Carlota Tigbao Yellow.
LCTR—La Carlota Tigbao Red.
H109—Hawaii 109.
Encar—Encarnacion.
25, 30, 31, 32—Represent years 1925, 1930, 1931 and 1932.
LC.—La Carlota.

With respect to its popularity among the planters, its rapid rise as a standard variety, its performance, etc., Dr. Alexander Gordon, chief of the department of agriculture and experiments of the La Carlota Sugar Central, has the following to say of the Alunan cane in his Seventh Annual Report as of June 30, 1938:

ALUNAN (L. C. 25/191), LA CARLOTA DISTRICT STANDARD CANE

The Alunan (L. C. 25/191) has now become our standard variety for this district. This is a signal success for the late Anselmo Labrador, plant breeder of the Granja Sugar Cane Experiment Station of the Bureau of Plant Industry.

As intimated early in 1935 (see Fourth Annual Report of this Department, April 16, 1935) Alunan (L. C. 25/191) is the standard crop of this district. At present (1938–39 crop) Alunan is grown in over 50 per cent of the La Carlota district cane area. The Badila which has been our standard cane for so long is now being left out. The P. O. J. 2878 which was at one time the craze of the district is now almost forgotten.

This favorite variety (Alunan) is the cause of high yields in this district. Henceforth, we shall take the Alunan for our standard cane.

The following Table 3, culled from the records of the Agricultural Department of the La Carlota Sugar Central before the lease of the station was effected, indicates the percentage of areas planted to the different cane varieties in that district:

TABLE 3.—*Showing the percentage of areas planted to different varieties during the last nine crop years at the La Carlota Sugar Central District.*

Variety	1930 to 1931	1931 to 1932	1932 to 1933	1933 to 1934	1934 to 1935	1935 to 1936	1936 to 1937	1937 to 1938	1938 to 1939
	P. ct.	*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*
Alunan (LC 25/191)[1]	-------	-------	0.97	2.83	7.23	15.00	20.00	34.49	50.93
Badila	30.94	38.98	37.81	43.95	44.70	40.00	40.00	31.28	28.85
P. O. J. 2883	-------	0.09	0.36	1.67	3.30	8.00	10.00	9.95	11.60
D. I. 52	1.37	3.00	3.50	4.26	5.65	5.00	4.00	5.04	7.25
P. O. J. 2878	0.99	7.10	16.41	24.92	19.04	25.00	20.00	1.86	1.23
New Guinea 24-A	4.42	8.27	7.90	5.00	3.90	1.00	1.00	0.46	0.14
Negros Purple	61.01	41.22	19.35	11.58	4.33	2.00	2.00	0.15	---------
All Others	1.27	1.34	13.70	5.79	11.85	4.00	3.00	16.77	---------

[1] The 1938–39 crop of the district is about 12,000 ha. Note the growing area planted to the Alunan cane.

The foregoing table is an up-to-date record of the plantings in the district as it includes the present crop of the 1938-39 cane-crop year. The rapid increase in the area planted to the cane within the last six crop-years speaks highly of the superiority of the variety over the other varieties of the district.

Graphs I, II, and III show the volume of the Alunan cane that was milled in the same Central during the 1937–38 crop-year

compared with other varieties in the district, and the yearly increase in tonnage of the Alunan cane milled by the Central during the 1932–33 to 1937–38 crop-years.

Regarding the total area covered by the Alunan cane in Occidental Negros, Table 4 gives 10,368.28 hectares for the 1937–38 cane crop. This figure has been arrived at after a thorough central to central checking conducted by the Twelfth Agronomical District.

TABLE 4.—*Showing the total area planted to the different varieties of sugar cane in the different mill districts of Occidental Negros during the crop year 1937–38.*

Centrals	P. O. J. 2878	P. O. J. 2883	D. I. 52	Badila
	Hectares	*Hectares*	*Hectares*	*Hectares*
Bacolod-Murcia	3,029.27	272.96	477.75	3,136.42
Bearing	1,618.40	161.84	20.23	40.46
Binalbagan	1,626.00	1,988.20	132.38	2,070.28
Danao	1,330.50			
Hawaiian-Philippine	1,387.86	714.96	845.02	3,674.47
Isabela	900.00	300.00	800.00	1,200.00
La Carlota [2]	183.75	986.04	499.44	3,098.43
Leonor	524.00	65.00		641.00
Lopez	1,341.83	181.44		544.48
Ma-ao	729.57	875.48	1,695.06	1,823.94
Manapla	5,182.13	1,652.73	76.36	2,040.58
Palma	261.00	870.00		174.00
San Carlos [1]	3,864.23			
San Isidro	528.00	452.00		151.00
Santa Aniceta		123.41	569.14	126.34
Talisay-Silay	2,432.06	875.91	1,804.75	934.75
Victorias	1,427.31	3,823.20	62.51	1,303.75
Totals	26,338.91	13,343.17	6,982.64	20,959.90

Centrals	L. C. 25/191	New Guinea	Negros Purple	Luzon White	H—109
	Hectares	*Hectares*	*Hectares*	*Hectares*	*Hectares*
Bacolod-Murcia	552.15	45.24	478.45		23.92
Bearing	131.38				
Binalbagan	697.25				
Danao					
Hawaiian-Philippine	750.00		45.95		
Isabela	757.00		480.00	20.00	
La Carlota [2]	3,416.54	45.67	14.43		
Leonor					
Lopez	152.23				
Ma-ao	1,021.40	291.83	656.63	72.96	
Manapla	1,140.58		14.02		64.93
Palma	348.00				
San Carlos [1]	33.03				
San Isidro	301.00				
Santa Aniceta	2.62		22.89		
Talisay-Silay	693.04		353.26		
Victorias	372.04	6.08	26.07		
Totals	10,368.26	388.82	2,091.70	92.96	88.85

[1] Sugar cane grown at Valle Hermoso, Oriental Negros is milled at Central San Carlos.

[2] Records of the Central for the 1938–39 crop show that Alunan cane occupies about 6,000 ha.

TABLE 4.—*Showing the total area planted, etc.*—Continued.

Centrals	Mauritius	P. S. A. 14	Hambledon	Other varieties	Total area
	Hectares	*Hectares*	*Hectares*	*Hectares*	*Hectares*
Bacolod-Murcia				60.69	
Bearing					
Binalbagan	1.85				
Danao				23.00	
Hawaiian-Philippine				369.94	
Isabela				84.00	
La Carlota [2]				1,661.69	
Leonor				35.00	
Lopez		105.66		370.80	
Ma-ao			218.87		
Manapla				203 95	
Palma				87.00	
San Carlos [1]					
San Isidro				75.00	
Santa Aniceta					
Talisay-Silay					
Victorias				472.93	
Totals	1.85	105.66	218.87	3,344.00	84,325.59

[1] Sugar cane grown at Valle Hermoso, Oriental Negros is milled at Central San Carlos.
[2] Records of the Central for the 1938-39 crop show that Alunan cane occupies about 6,000 ha.

With respect to the production of the Alunan cane, both in tonnage and in piculs per hectare, Table No. 5 gives the results of the 1937–1938 commercial cane planting of the Granja Sugar Cane Experiment Station in its rôle as one of the planters of the La Carlota Mill District.

TABLE 5.—*Showing the production of the Alunan Sugar Cane as compared with that of other varieties in the 1937–38 commercial cane planting of the Granja Sugar Cane Experiment Station.*

Variety	Area hectare	Kind of crop	Production				
			Total tons cane	Total piculs sugar	Tonnage per hectare	Piculs per hectare	P/T
Alunan (L. C. 25/191).	10.97	Plant cane	1,263.90	2,130.59	115.22	194.22	1.685
Do	8.46	Ratoon	530.30	1,120.99	62.68	132.50	2.113
Badila	2.39	Plant cane	178.90	287.44	74.85	120.27	1.607
Do	4.39	Ratoon	285.10	532.55	64.94	121.31	1.868
DI 52	0.26	Plant and ratoon	14.81	24.57	[a] 56.96	[a] 94.50	1.659
PSA 14	0.45	Plant cane	29.00	49.57	[a] 64.44	[a] 110.16	1.711

[a] Estimated production per Ha.
NOTE.—Milled from 26.92 hectares to cover the station quota of 4,228 piculs.

The results as shown in Table 5 indisputably establish the superiority of the Alunan cane over all other varieties in both cane tonnage and in piculs of sugar. These results, too, are in

accord with the general production obtained in Negros for the different cane varieties whereby the Alunan averages 140 to 145 piculs while the other next leading varieties like the P. O. J. 2878 and the Badila, average 125 to 130 piculs per hectare. Figuring the extra worth of the variety in terms of cash returns to the industry, with the crop just milled (1937–1938) when 10,368.26 hectares in the entire province were planted to the Alunan cane, a difference of 15 piculs per hectare stands in favor of the Alunan cane. This difference of 15 piculs multiplied by 10,368.26 hectares gives 155,523.9 piculs. At ₱7 per picul, the 1938 market quotation for sugar, it gives the astonishing figure of ₱1,088,667.30 extra money accruing to the Negros planters without utilizing additional areas or incurring extra expenses. This is a worthy accomplishment of the Granja Sugar Cane Experiment Station. In lowering the cost of production of Philippine sugar to enable the industry to withstand stiff world competition when the preferential tariff enjoyed by our sugar in the United States is gradually withdrawn, we have in the high yielding Alunan cane a major contribution to the crying need of present day Philippine export crops, i. e., lower cost of production.

The Alunan cane is as yet the fourth ranking variety in hectarage in the whole Negros but for the present crop (1938–1939) it tops the P. O. J. 2883 and follows closely the Badila. The La Carlota mill district alone, the district with the biggest quota planted over 6,000 hectares to the Alunan cane last season out of its total hectarage of about 12,000 hectares. (See Tables 3 and 4).

In brief, to evaluate the present worth of the variety in terms of pesos, using the preceding figures as a basis, the Alunan is now a ten-million-peso sugar-cane variety.

The future of the Alunan cane is fraught with great possibilities, based upon its meteoric ascendancy in so short a period of six crop-years. It bids fair to play an important rôle in the reckoning of Philippine sugar.

WORK ON MISCELLANEOUS AGRONOMY AND HORTICULTURAL CROPS

1. While the chief work of the station, for many years, was on sugar for the benefit of the sugar industry, impending economic readjustment and changing agricultural conditions of the Philippines in recent years demanded a reorientation and pointed to the danger of one crop specialization as in the case

of sugar in Negros. The station, in anticipation of the adverse future looming ahead of the sugar industry in view of the sugar limitation, accordingly directed its activities in the main towards the launching of a long-range crop diversification program for the province. The station was thus called upon to study crop substitutes and their relative adaptability and to produce and distribute suitable varieties of planting materials. It had to adhere closely to this program in order to help bring about the desirable agricultural adjustment.

The work of the station on miscellaneous field crops was invaluable to the farmers in guiding them properly as to the most feasible means of utilizing large areas released from sugar cane, which otherwise would lie idle. The miscellaneous field crops advocated and produced by the station for the farmers in this crop diversification program are as follows:

(*a*) *Rice and corn.*—The station produced on a commercial scale for distribution to farmers selected and improved seeds of good varieties of corn and rice, such as F1 seeds of the Calamba Yellow and the Cebu corn, and seeds of the standard upland rice like the Dumali, Inantipolo, Kinastila, Magsanaya, and others. These are being planted on an extensive commercial scale by Occidental Negros farmers among whom are Messrs. Alfredo Montelibano and Fernando Arguelles of Murcia at Haciendas Binitin and Caliban, respectively; Jose Fuentebella and Antonio Gonzaga of Bacolod; Guillermo Presbitero of Valladolid; and the owners of Haciendas Boyog and Carminia, Escalante and a number of nearby haciendas in the La Carlota mill district.

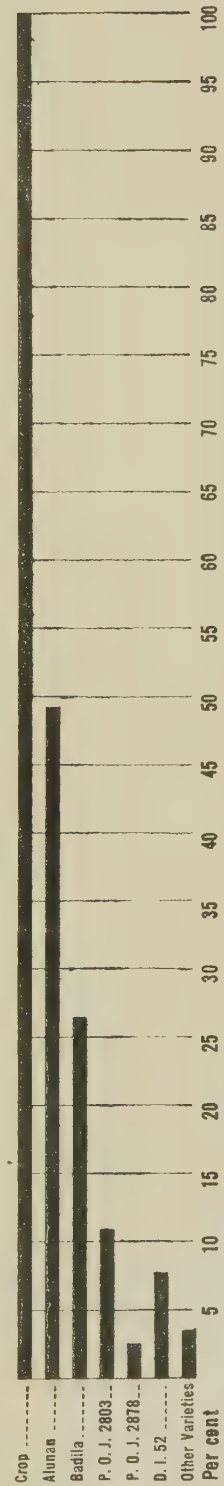
Negros is gradually becoming an important upland rice and corn growing province. The initial interest shown by the farmers to the growing of these crops may be directly attributed to the promotion work of the station in this regard.

(*b*) *Root crops.*—Root crops, like the standard varieties of cassava, peanuts, gabi, ubi, arrowroot, camote, and other crops, were also planted in order to supply planting materials to the people. These crops are highly adapted to the soil and climatic conditions obtaining in Negros and fit very well into the scheme of crop diversification for the province. While cassava and peanuts, by reason of their bigger commercial possibilities, are most in demand, still the interest in camote, gabi, ubi, ginger, and other crops, was appreciable enough to warrant their being

allowed substantial berth in the crop diversification scheme for the Province of Negros.

Cassava as a commercial crop of the province has very bright prospects not only because of the favorable climate and soil but also because of the availability of ready capital and excess machine power in the different sugar centrals that could be readily utilized in the industrialization of the same. To be sure, plans are now afoot by some big planters in some of the mill districts to put up cassava factories either under the centrals' management as in the case of sugar cane or as separate plants solely devoted for the purpose. The big cassava planters of the province are: Don Gil Lopez, Dr. Doroteo Cabayao, and Dr. Elias H. Pañganiban of Faraon, Cadiz. Dr. Gil Lopez has a cassava factory which was established in 1936 in coöperation with the station. The station was instrumental in enlisting the interest of the public in the planting of this profitable crop.

(*c*) *Fiber and oil crops.*—The fiber and oil crop projects of the station date back as early as 1905 and were continued in operation up to about 1920 when these activities were transferred to other stations of the Bureau so that as much attention as possible could be devoted to sugar cane. Varieties of fiber and oil crops were cultured, among which were abacá, sisal, maguey, kapok, ramie, panama palm and jute; castor oil, and other oil plants. Results of studies and experiments conducted in this direction formed the basis of information of the Bureau on these crops. In later years the silkworm and the African oil palm cultures were undertaken for adaptability trials. When the abacá project was started some districts were planted to the crop but with the craze for sugar cane planting gullies and



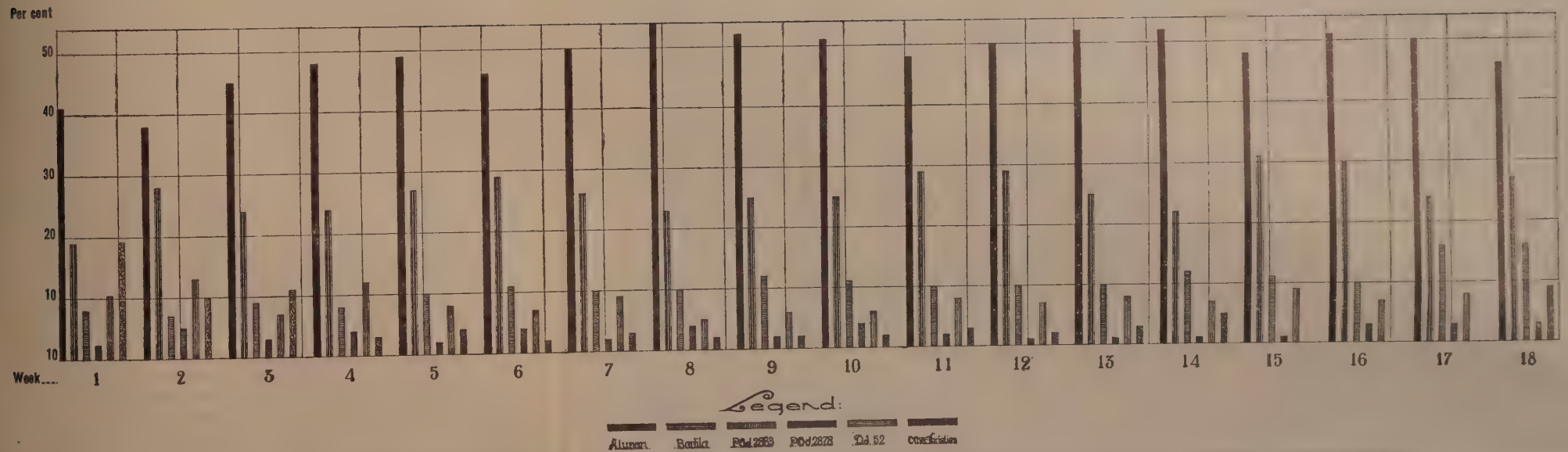
GRAPH I.—Comparing the Aluman cane with other varieties in percentage of cane milled at the La Carlota Sugar Central (from the Central's records). Crop year 1937–38.

foot hills which were suitable for abacá culture were in turn cleared and converted into sugar-cane areas. Some abacá varieties are still extant in limited areas at the foot of mountains at La Castellana, Isabela, Murcia, Manapla, and Cadiz and their origin can be traced to the abacá project of the station. Abacá, while a minor crop of Negros, fills in an important domestic need considering that the province is highly agricultural.

(*d*) *Derris.*—The derris project was started by the station in 1935 as one of the replacement crops occasioned by the sugar limitation. During these last 3 years derris has elicited great interest on the part of the planters. In anticipation of a large demand for planting materials, the station took the lead in propagating the plant on a big scale. Selected plants ranging from 4 to 8 per cent in rotenone content gathered by the personnel of the station in their travels within the province were planted as original stocks. The station began the distribution of cuttings during the last half of 1937 and from the 8 hectares planted, there were supplied 120,392 cuttings in 1937 and 603,361 in 1938, up to the time the station was transferred to the new management. The money value of this distribution (at ₱5 per thousand cuttings) and the hectarage covered when planted with these cuttings, stand as an accomplishment of the station within so short a span of time, to say nothing of the services given to Negros farmers in the way of information and cultural instructions on the crop. Today Negros has about 580 hectares planted to derris, in the promotion of which the station played a major rôle.

(*e*) *Beans.*—With respect to minor horticultural crops the station conducted trials and studies on different legumes such as different varieties of soy bean, cowpeas, kibal, sitao, *panubigan* bean, bountiful bean, and other beans. The objects were to determine the possibilities of the crops for commercial production in connection with crop diversification work; to conduct studies on the best time and manner of culture; and to determine their secondary uses as soil renovators, and as animal feed.

The possibilities of beans for Negros are bright as the soil and climate are favorable to the growing of the crops. The cultural trials conducted by the station along this line were instrumental in popularizing the commercial planting of the *panubigan* bean, the variety popularly called "habichuelas ver-



GRAPH II.—*Showing the weekly milling percentage of the Alunan cane as compared with that of other varieties at the La Carlota Sugar Central, crop year 1937–1938.*

des" having red and white colored dry beans. Special mention is made of the different varieties of soy beans, from the old Ami variety to the recently introduced and improved kinds as the Macoupin, Otamao, Danfield, Mis Dixie 33, and other varieties. The results of the trials proved beyond reasonable doubt the importance of the crops, both in the production of beans and forage and cover crops. Soy bean may in the near future form the basis of new industries on oil, sauce, and paints in Negros.

(*f*) *Forage and cover crops.*—In connection with the previous animal husbandry project of the station, different forage grasses such as the Uba cane, Napier, Guatemala, Sudan, Para and Guinea grasses were also introduced, tried and cultured.

Negros was and still is dependent to a great extent on work animals for its farm operations, and realizing the value of grasses for feed, the station distributed to the farmers planting materials of these different grasses. The Para and the Guinea grasses are now the standard feeds for big and small animals in the province. The extent to which these grasses are being grown can better be appreciated by mentioning the fact that Negros has a number of work animals in all haciendas. Incidentally, the rich families such as the Ledesmas, Jalandonis, Aranetas, Montelibanos, Montillas, Ascalons, Ferias, Presbiteros, Lopezes, and others, are raising cattle, horses, poultry and swine. The Guinea and Para grasses form the bulk of green feeds of these animals as these forage grasses are now grown throughout the province. The raising of these forage grasses had its origin in the initial work of the station in conjunction with the work on livestock.

With respect to cover crops the station popularized the use of such cover crops as Centrosema, Calopogonium, Tephrosia, and ipil-ipil. Farmers availed themselves of the use of these cover crops either as soil renovators, as weed exterminators or as shade plants. The popularity in the use of these crops can be gauged by their presence in a number of big orchards throughout the province.

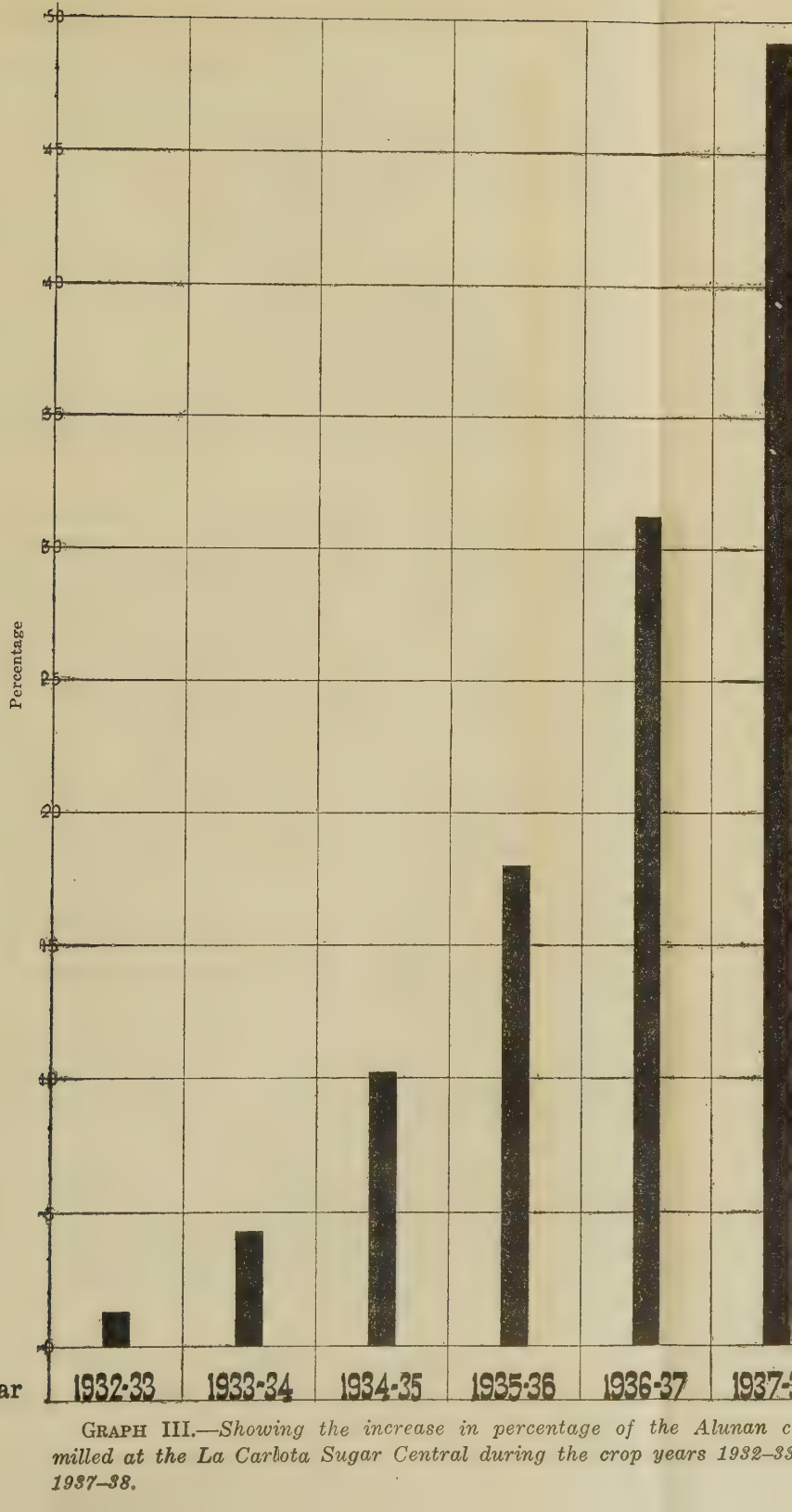
(*g*) *Vegetable project.*—The station also devoted part of its area to the planting of a variety of vegetable plants such as the eggplant, papaya, pepper, patola, seguidillas, sincamas, upo, cucumber, squash, condol, talinum, and malungay. The main object was the production of planting materials (seeds and cut-

tings) for distribution at the Central Office, the cultures serving as demonstration plots. Seeds were kept at the station to supply local demand and the district's needs for rural improvement work. The planting of vegetables around the homes of laborers in hacienda communities became widespread as a result of the station's efforts in this regard.

(*h*) *Tobacco project.*—Late in the 1934–1935 crop year, when the sugar limitation law was enforced, the station introduced the growing of the wrapper and the cigarette tobacco varieties for adaptability trials in the search for other crop substitutes. The project was carried yearly until the station was leased and the results obtained during four years showed promise for the wrapper varieties. Widespread interest was aroused in the growing of the wrapper tobacco but the uncertainty of the market for the crop just now is a deterrent among the able planters. During these years the station became one of the big sources of seeds of wrapper and cigarette tobacco for distribution by the Central Office.

With the marked similarity of the rainfall and climatic conditions of Negros to those of Java and the fact that actually tobacco is one of the principal crops of the province, it is only a matter of time now with this program of agricultural adjustment when the growing of tobacco of a better quality and on a bigger scale will be seriously undertaken. Forerunner of this is the erection in 1937 of a modern tobacco curing flue by Mr. J. Cooper at Hacienda Boyog, Escalante, one of the towns of the province noted for its tobacco crop.

2. *Nursery and orchard projects.*—The raising of fruit tree seedlings of commercial value became part of the routine work of the station as soon as seeds and propagating materials were obtained from its bearing trees planted in 1915. The work, however, was given more impetus when the operation of the station was bolstered up with the Seed Farm Fund of 1928–1929. Propagation on a commercial scale of different seedlings, as well as budded, grafted and marcotted plants was then undertaken for purposes of distribution. Then too, with the sugar limitation which implied the necessity of crop diversification, the nursery work was stressed. In the last few years since the limitation took effect, the demand for fruit tree seedlings was



GRAPH III.—*Showing the increase in percentage of the Alunan c milled at the La Carlota Sugar Central during the crop years 1932–33 1937–38.*

especially great as will be seen in the following records of distribution:

	Number of seedlings	
1935	23,344	budded, grafted and marcotted.
1936	21,993	Do.
1937	16,621	Do.
1938 (January to June 30)	15,867	Do.
Total	77,825	

To the station goes the credit for establishing a number of big orchards in the province. The general interest among the people in the planting of trees was doubtless brought about by the fact that the station consistently maintained within its premises model orchards of different kinds of fruit trees including coffee.

Negros, for instance, is considered at present to be one of the leading avocado producing provinces. It produces besides other fruit trees like the caimito, tiessa, serali, oranges, and pineapple, on a semi-commercial scale in various haciendas. Among the biggest fruit orchards in the province are those owned by Don Nicolas Lizares, Mayor Alfredo Montelibano and Don Generoso Villanueva of Bacolod; Assemblyman Pedro Hernaez, and Albino Jison of Silay; North Negros Central and Dr. Doroteo Kabayao of Manapla; Victorias Central, and the Valderrama family of Victorias; Don Gil Lopez and the Avanceña family of Cadiz; Domingo Siocon and the Mapa family of Talisay; the Mambucal Spring, summer resort of the province in Murcia; Don Aguedo Gonzaga and Don Raymundo Yusay of Bago; Don Espiridion Presbitero and Doña Dolores Infante of Valladolid; Don Toribio Echarri and Don Vicente Jimenez Yanzon of La Carlota; Don Enrique Esteban and Jesus Esteban of La Castellana; Don Antonio Milan and the Montilla family of Isabela and Ilog; the Binalbagan Sugar Estate and the Marquez Estate in Binalbagan; and haciendas in other towns of the province.

The educational aspect of the work, whereby the people ultimately learned the value of fruits in their daily diet should not be lost sight of. In all these years, the station has been known in the entire province for its myriad variety of fruits and the popularity now enjoyed by the avocado, tiessa, serali, caimito and oranges in the local markets remains as a permanent legacy bequeathed to the Negros people by the station.

At the time of its transfer the station had the following fruit trees producing the necessary seeds and budsticks, for propagation purposes to supply local needs as well as those of the Central Office, other stations of the Bureau, provincial nurseries, and private parties:

Name	Number of trees	Years planted	Name	Number of trees	Years planted
African oil palm	50	6	Kapok	114	18
Anona hybrid	2	18	Kayam	1	15
Ates	13	8	Ketembilla	2	22
Avocado	378	3–22	Lanzones	6	11
Alpay	7	9–20	Lemon	2	6
Crab-apple	1	15	Lime (2 varieties)	7	6
Biriba	9	9–18	Lemasa	72	6–22
Banati	1	22	Lauriva	1	22
Bael	2	22	Lamuta	1	22
Bananas	256		Malungay	15	4
Beriba	3	6–9	Mango	48	4–22
Binucao	4	9–18	Mabolo	9	4–22
Chico	13	8	Mandarin (12 varieties)	175	2–22
Sweet camias	2	22	Marang	1	22
Cefal is	1	22	Narra tree	5	7–10
Caimito	41	9–18	Papaya	36	3– 6
Calamondin	109	6–22	Pitanga	2	18
Camansi	4	22	Pine tree	2	3
Carambola	5	22	Perunkila	1	6
Chico mamey	3	18	Pummelo (4 varieties)	22	3–20
Coffee	3,837	22	Rimas	1	2
Cacao	13	10	Rambutan	9	2– 8
Cashew	2	8	Sweet orange (16 var.)	140	4– 6
Date palm	1	22	Sour orange	2	6
Genipa	2	18	Santol	15	22–38
Guanabano	8	8	Strychnus spinosa	3	18
Gomihan	2	22	Serali	8	20–22
Guava	5	18	Tizon	19	6
Grapefruit (2 varieties)	6	6	Tamarind	2	22
Huani	2	9–20	Tersana	2	6
Hevi	5	9–18	Tiessa	9	3–18
Iba	2	22	Tangelo	2	6
Icaco	1	18	Wampi	2	9
Ipil (timber)	5	7–10	Yambo	7	6–22
Kanari	2	16–22	Zapote	1	20

3. *Agricultural extension work.*—The activities of the station were not limited to projects within the confines of the farm. The results of its work were also extended to the farming public. The experiments conducted within, and the extension work without, complimented one another in bringing about the rapid promotion of the agricultural development of the province. Beneficial results of agricultural research obtained, high yielding seeds or better planting materials produced, better agricultural practices and methods evolved were all rapidly disseminated for

the benefit of the farmers. Agricultural extension practices such as actual field demonstrations, informative instructions, cooperative plantings, crop drives, farmers' days, community assemblies, participation in local and provincial fairs, etc., were all availed of to the advantage of the people. It is through a strict adherence to the policy of public service that the station gained the confidence of the farmers of Negros. Its contribution to the progress of agriculture in Negros and other parts of the Islands can be attributed to this confidence in and reliance on its leadership.

B. Animal Industries

One of the early projects of the station was that on animal husbandry which was begun in 1910 with the introduction of a few head of Indian cattle. Since then foreign breeds have been introduced. The object of the work was to promote the animal industry in the district through the introduction of better foreign breeds and the improvement of native breeds through upgrading. In this work, the station contributed material benefits to the Negros people in more ways than one, chief among which are the improvement of their native stock of domestic animals with the introduction of the Arabian and Thoroughbred blood in horses; the Indian cattle blood in cattle; that of the Berkshires, Poland Chinas, and Duroc Jerseys in swine; that of the White Leghorns, the Cantonese and the Rhode Island Reds, in poultry. The blood of these imported improved breeds is now very evident in the common stock breeds in the various haciendas in Negros. Another major accomplishment in connection with the animal industry project was the work in the control of animal diseases like rinderpest, surra, the foot-and-mouth disease, and other diseases which constantly menaced the work animals and herds of the province in the early years of the station.

The animal husbandry project of the station was closed with the creation of the Bureau of Animal Industry in 1929 by virtue of Act No. 3639 splitting the then Bureau of Agriculture into the two sister Bureaus, the Bureau of Plant Industry and the Bureau of Animal Industry. The latter Office put up its own station within the land apportioned to it. The same line of activities in animal improvement as started by the station is still being pursued by the Animal Industry Stock Farm for the benefit of the Negros people.

C. Expenses and Income

As stated elsewhere in this paper, the station was the most profitable experiment station of the Bureau. Being an experiment station, it was not expected to give monetary returns, and yet it justified its later operations by returning to the Government more than the annual investments made in maintaining it. A close study of the financial status of the station for the last five (5) years beginning 1934 will bear us out in this:

Year	Expenses	Gross income	Net income
1934	₱12,969.02	₱27,365.34	₱14,396.32
1935	9,126.02	20,965.59	11,839.57
1936	23,811.69	30,249.59	6,437.90
1937	22,423.58	28,438.81	6,015.23
1938	13,763.84	28,331.22	14,667.38
Total	82,094.15	135,350.55	53,356.40

PRESENT WORTH AND INVENTORY OF STANDING CROPS, PROPERTIES AND PRESENT IMPROVEMENTS

In presenting an honest appraisal of the work of the station at the time of its transfer, August 15, 1938, an inventory of the standing improvements alone is not all that should enter into consideration. There is the good will that the station acquired based upon the disinterested public service in agriculture that it offered since the beginning. This unselfish public service was largely what earned for the station the good name and the credit that it enjoyed in its relations with the public. Pecuniary consideration is no measure of justification for the intrinsic merit of what the station has done or stood for.

The following is the inventory of the standing permanent plantings and annual crops at the time of transfer, as culled from a report of Mr. F. G. Galang, Chief of the Horticulture Section of this Bureau:

Total estimated value of standing annual and permanent plantings of economic plants	₱48,692.75
Total cash income from January to August 15, 1938 (date of transfer)	28,331.22
Total	₱77,023.97

The inventory values of the land, buildings, equipments, tools, and other properties of the station as appraised by the Property Officer of the Bureau at the time of transfer amounted to ₱522,001.37.

The total money value, therefore, that was represented in the leasing of the station amounted to ₱599,025.34, of which

the amount of ₱496,312.40 represented the value of the land and its sugar quota. The sum of ₱102,712.94 represented the station's income from January to August and the value of standing improvements and working equipments essential in the operation of the farm.

SUMMARY

1. With the signing of the contract of lease by and between the Agricultural Service, Inc., and the Philippine Commonwealth, on July 23, 1938, the Granja Sugar Cane Experiment Station terminated its activities under Government operation and supervision.

2. The rental is ₱12,000 per annum.

3. The Granja Sugar Cane Experiment Station was the best developed and the most profitable experiment station of the Bureau.

4. In the last five years of its operation, 1934–38, under the management of the writer, the station showed the following expenses and income:

Expenses	₱82,094.15
Gross income	135,350.55
Net income	53,356.40

5. At the time of transfer it was 48 years old—10 years under the Spanish régime, 35 years under American rule, and 3 years under the Philippine Commonwealth. It had seen antiquated muscovado mills transformed into modern sugar centrals. Its activities had grown from the old hit-and-miss farming to that of modern and scientific methods.

6. The entire area of 496.3124 hectares is all under cultivation and has 116 families living within its confines with a total population of 574 persons who are dependent for their livelihood on the station.

7. The station has a sugar quota of 14,134 piculs.

8. It helped the sugar industry by:

(*a*) Introducing and conducting trials and studies on both foreign and local sugar-cane varieties.

(*b*) Distributing superior sugar-cane varieties to planters.

(*c*) Conducting researches and experiments on better cultural methods in sugar cane growing and improved methods of sugar manufacture, and studies on sugar-cane pests and diseases and their control.

(*d*) Producing the famous L. C. 25/191 (Alunan sugar cane), now one of the standard sugar-cane varieties of Negros, and other promising seedling canes.

9. With the advent of sugar limitation it pushed forward the program of crop diversification as a remedial measure in agricultural adjustment. This crop diversification program was the outcome of trials and experiments on crop substitutes resulting in the production of selected and improved varieties of seeds and plants for crop promotion drives. The province since the limitation is gradually being weaned away from one crop specialization to crop diversification. Industrialization to harness excess power in centrals may easily follow the production of cheap raw materials.

10. Its work on animal industry materially improved the breed of domestic animals and made the province safer from the ravages of serious animal diseases than in the past.

11. With its disinterested service in the promotion of agriculture, the station gained public confidence. It was this confidence that bestowed upon the station the enviable agricultural leadership it enjoyed among the people during the years of its existence.

12. Its name "La Granja" is a household word among the people of the province as well as among farmers in nearby Visayan provinces and taken as the seat of modern agricultural practices and advancement; noted for its selected and improved planting materials, its fruits and animals.

All things considered, the Granja Sugar Cane Experiment Station led 36 years of life and disinterested public service to the full.

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ILLUSTRATIONS

(All views taken at the Granja Sugar Cane Experiment Station, La Granja, La Carlota, Occidental Negros)

PLATE 1

Characteristic stalks and nodes of different sugar cane varieties.

PLATE 2

Cutting a matured hybridized arrow, the seeds of which are for germination.

PLATE 3

Seedling canes in the nursery during the years of hybridization work.

PLATE 4

FIG. 1. Java 247, male parent of Alunan cane.
2. Badila, female parent of Alunan cane.
3. Alunan cane (L. C. 25/191), one hill.

PLATE 5

FIG. 1. L. C. 25/190 (Labrador cane).
Parentage, Java 247 and Badila.
2. L. C. 30/100 (La Granja cane).
Parentage, P. O. J. 2878 and P. B. 119.

PLATE 6

A single plant of the La Granja cane, 6 months old.

PLATE 7

A field of Alunan cane.

PLATE 8

FIG. 1. A field of rice, variety Apostol.
2. A field of Calamba Yellow corn.

PLATE 9

Dumali (upland rice), a month old, interplanted with Calamba Yellow corn.

PLATE 10

Fields of different varieties of cassava.

PLATE 11

A field of cotton, Cleveland big boll variety.

PLATE 12

FIG. 1. African oil palm.
2. Bunches of fruits, nuts and seedlings of the African oil palm.

PLATE 13

A field of derris (Derris elliptica).

PLATE 14

FIG. 1. Soy bean (Macoupin) in the foreground; Bountiful bean a little behind.
2. Singapore sitao grown for the production of seeds.

PLATE 15

Guinea grass (forage grass).

PLATE 16

FIG. 1. Tobacco seedbed.
2. Tobacco plants with fully mature leaves, ready to be harvested.
3. Tobacco field, partly harvested.

PLATE 17

FIG. 1. Okra in the foreground, flanked by Hawaiian pineapple and Mexican June corn.
2. A field of mulberry trees with eggplants planted in between the rows.
3. A field of wheat.

PLATE 18

FIG. 1. The source of the springs for gourami, frogs, ducks, "dalag" and "martinico" beds.
2. Frog culture.

PLATE 19

FIG. 1. An avocado tree.
2. Caimito fruits.
3. Caimito tree with fruits.

PLATE 20

FIG. 1. Budded Washington navel orange, 5 years old.
2. Tiessa fruit, long variety.

PLATE 21

FIG. 1. Budded pineapple orange, 5 years old.
2. Marcotted serali.

PLATE 22

Early stock of Indian cows and bullocks.

PLATE 23

Park and gardens of the Station.

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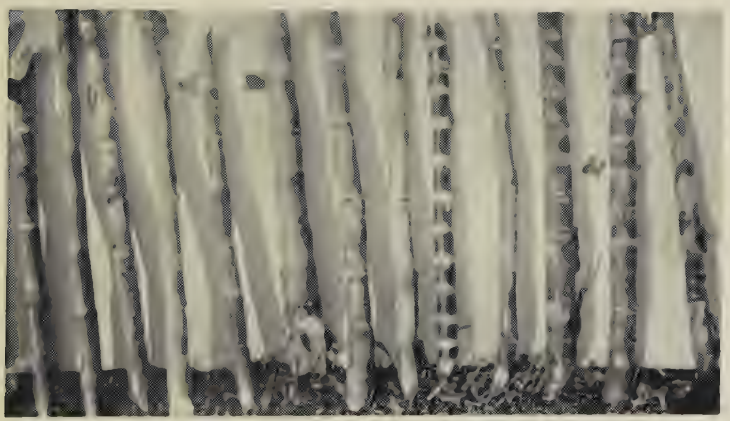

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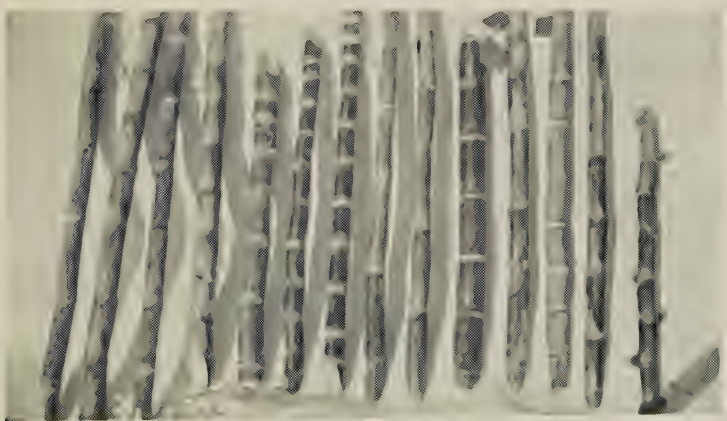

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PLATE 1.

PLATE 2.

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PLATE 9.

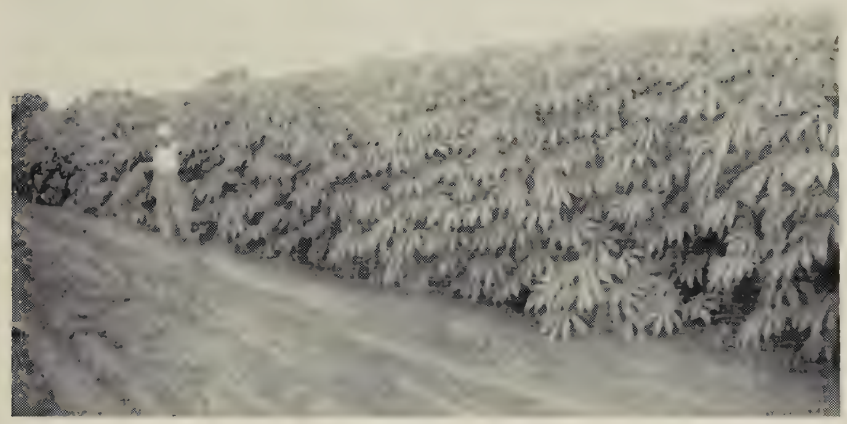

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PLATE 10.

PLATE 11.

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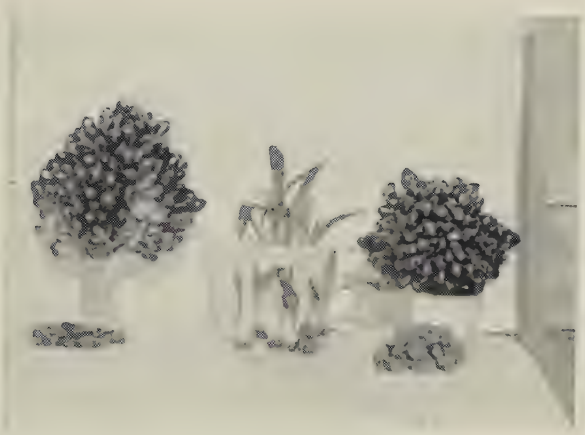

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PLATE 12.

PLATE 13.

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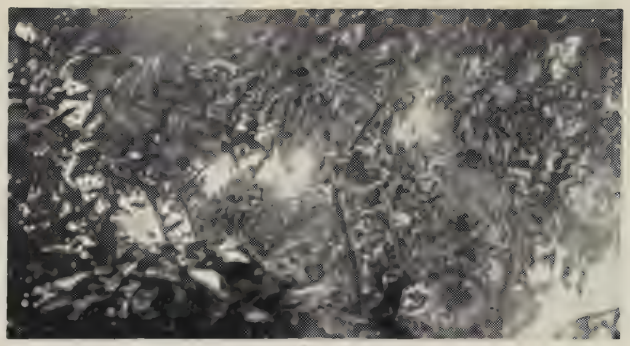

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PLATE 19.

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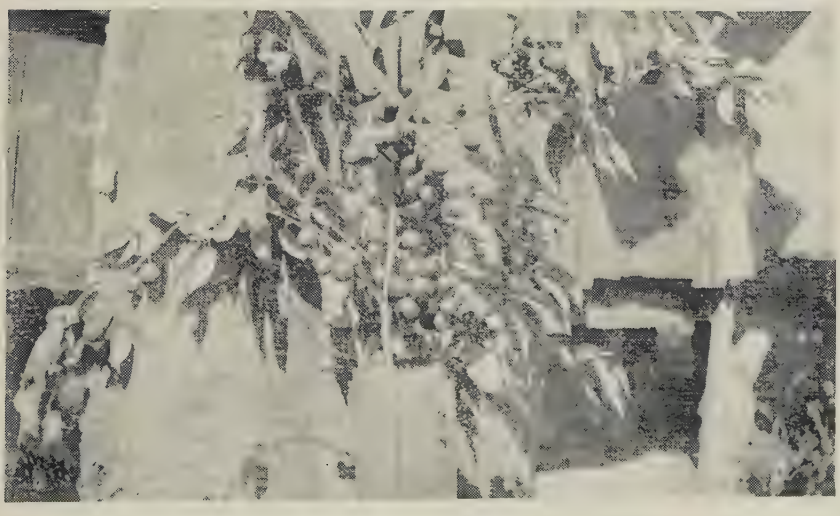

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PLATE 21.

PLATE 22.

PLATE 23.

THE CACAO INDUSTRY IN THE PHILIPPINES *

By Epitacio A. Lanuza
Of the Horticulture Section, Bureau of Plant Industry

INTRODUCTION

Concededly one of the most profitable crops in the Philippines (given favorable conditions and free from the menace of serious pests and diseases) is the cacao, *Theobroma cacao* L., belonging to the family Sterculiaceae. A native of tropical America, cacao was first introduced into the Philippines by the Spaniards at an early date. From Mexico and Central America, the cultivation spread to the West Indies and to South America finally radiating as far as West Africa, Ceylon, Java and in many parts of the world including the Philippines. Merrill describes the plant as follows:

> A tree 3 to 5 meters high. Leaves 15 to 40 cm. long, acuminate, base rounded oblong-obovate to oblong, base shortly 3-nerved. Flowers solitary or fascicled on the trunk and branches, yellowish or nearly white, pedicelled, about 1 cm. in diameter, the erect lobes of the staminal column purplish. Fruit oblong, 10 to 15 cm. long, prominently wrinkled, yellow or purplish. Seeds numerous. Flower all the year round.

Barrett, in a stirring lavender account about cacao, tells us that at the time of the Spanish invasion of Mexico in the early part of the 16th century, "chocolatl" (the Aztec name for cacao) was used both as a popular beverage material as well as a product which literally served the purpose of "coin of the realm" or as a medium of exchange, its seeds being used by the natives in paying taxes and tributes. In the middle of the 17th century the chocolate, a term first used by the English, definitely entered in the European diet.

Cacao is still a crop of great commercial possibilities in the Philippines both for local consumption and for export. The best available areas in the cacao-producing countries have been fully developed in the past decade, leaving only marginal lands to meet the needs of increasing consumption. The older producing countries are finding it more and more difficult to maintain their normal production. This, abetted by the fact that new uses of cacao are being discovered from time to time, may in due time usher in a condition when the consumption of cacao

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* Prepared for the Golden Gate International Exposition, San Francisco, Cal., U. S. A.

will outstrip production to such an extent as to cause a serious shortage in the supply of raw cacao for manufacturing purposes. While the commercial possibilities of this crop have long been a matter of common knowledge among the rank and file of Filipino farmers, still the progress of the Philippine cacao industry has been relatively slow and niggardly and no attempt whatsoever has been made to establish big cacao estates in the Philippines. At present cacao is cultivated in the Islands mostly around the houses.

STATISTICAL DATA

Up to about 1912, Ecuador held undisputed control of the world's production of cacao until affluent British interests in the Gold Coast brushed her aside to become the world's top cacao producer.

At present, there are 28 important cacao-producing countries in the world with a combined annual shipment of 622,000 tons. The British colonies alone produce about 62 per cent of the above figure and the other countries 38 per cent.

There are 41 countries importing cacao beans—principally the United States, Germany, Netherlands, Great Britain and Ireland with a combined annual importation of 584,400 tons.

The bulk of Philippine annual importation of cacao amounting to about 2,000 tons, valued at more than a million pesos come mostly from the British and the Dutch East Indies with the exception of manufactured cacao valued at over five hundred thousand pesos which we generally import from the United States.

In 1936 a total of 2,211,190 trees were planted in the Philippines occupying an aggregate area of 1,548 hectares. Of these trees, 1,190,850 were in bearing during the same year and yielded 798,080 kilos of cacao seed valued at ₱601,810. The Philippine average yearly consumption amounts to over three thousand tons valued at nearly two and a half million pesos.

During the same period the ten leading cacao-producing provinces named in the order of their consequence are Oriental Negros, Cebu, Bohol, Cavite, Leyte, Iloilo, La Union, Tayabas, Occidental Negros, and Pangasinan. More than 55 per cent of the total crop in 1936 was raised in these provinces.

In no instance has Philippine exports of cacao reached appreciable quantities to warrant its being listed alongside the country's minor exports. Our cacao exports, including re-exports (cacao imported into the Islands and then exported back

to China, British Indies, French East Indies, Hongkong, and Japan) in 1936 and in 1937 aggregated a trifle 10,179 kilos valued at ₱4,655 and 4,630 kilos valued at ₱1,932, respectively.

CULTIVATION

Varieties.—The principal cacao varieties known to world's commerce as mentioned by Barrett are: (1) Criollo of which there are three or four recognized types like the Venezuela, Nicaragua, and Trinidad; (2) Forastero; (3) Calbabacillo; (4) Pentagona or Alligator; (5) Bicolor or Tiger; and (6) Shaerocarpa. The same author mentioned certain strains of the Forastero and the Criollo as the principal Philippine cacao varieties. No systematic study has been made thus far of the existing cacao varieties in the Philippines. However, two easily recognized types are found cultivated, namely, the red or purple and the white or yellow. Of these two the most widely grown is the purple. An intermediate type known locally as "Linomot," is grown in the Bicol region.

Soil and climatic requirements.—Cacao being strictly a tropical plant, the existing soil conditions, seasons, and distribution of rainfall in most parts of the Philippines make the country ideal for the commercial planting of the same. Then, too, the Islands fall within the geographical zone admittedly suitable for the successful growing of cacao—to be precise between latitudes 4° 30′ and 21° 30′ north and longitudes 116° and 127° east.

Cacao thrives best in a well drained fertile loamy soil with a substantial amount of humus and with a mean temperature of 26° C. to 28° C. and a precipitation of 1,600 to 2,200 mm., which is fairly well distributed throughout the year. A pronounced dry season is not conducive to the growing of cacao on a commercial scale.

Not only should the soil and rainfall be favorable but also the land planted be well beyond the paths of strong winds. Adequate provision for windbreaks should be made therefore in lands which are exposed to strong winds. Soils with an elevation not more than 800 meters above sea level are most suitable for cacao culture.

Extensive areas for the growing of cacao are still available today in many parts of Mindanao, the Bicol region, Mindoro, Palawan, Isabela and in the Visayan Islands. In these sections alone there are vast tracts of land whose soil and climate are made to order for the delicate requirements of cacao trees.

Propagation.—In the Philippines, vegetative propagation especially budding of cacao has not been extensively practiced. The only system of propagation in vogue is by seeds. The farmers select the best mature pods from productive trees that they can get hold of for seed purposes. Because seeds easily lose their vitality, they are, therefore, planted immediately after the pulp and membranes have been washed off with clean fresh water.

The following methods are in vogue in the sowing of the seeds: (1) Direct in bamboo tubes or pots with good garden soil, planting a seed in each tube or pot at a depth of 2 to 3 cm. below the surface. A conveniently-sized hole for drainage is made at the joint or node of the bamboo tube. At the bottom pieces of gravel or stones are placed before putting in the soil; (2) in receptacles devised for the purpose, such as bark of wood, or banana leaves in case these materials are easily and economically obtained. Sowing in such receptacles proceeds in the same manner as that in bamboo tubes; (3) in seed boxes or seed beds, and for the former using a mixture of compost and garden soil as medium, or of fertile soil mixed with fine river sand. In all cases it is essential that partial shading be observed.

In the last method the seedlings are later on potted in bamboo tubes when the first pair of true leaves appear. In potting the seedlings the main roots are nipped off to induce branching.

Planting.—When the seedlings reach a height of about 40 cm. or more they are transplanted in permanent fields. Transplanting is done at the beginning of the rainy season. The seedlings are set in holes of at least 40 or more cubic centimeters and distanced at 4 to 5 meters. The seedlings are planted at the same depth as in the pot. The holes are then filled with rich surface soil. The newly planted seedlings are watered after setting whenever it is necessary. It will cost from ₱150 to ₱250 to plant a hectare of cacao depending upon the kind of land, and between ₱25 to ₱50 a hectare to maintain the plantation.

Cultivation.—It is essential that cacao be partially shaded. For this purpose leguminous trees such as ipil-ipil, *Leucaena glauca* (Linn.) Benth., and madre-cacao, *Gliricidia sepium* (Jacq.) Steud. are used. To a very limited extent other shade trees are used, such as avocado, *Persea americana* Mill., nangca, *Artocarpus integrifolia* L. f. and other fruit trees. Without permanent shade at the start, temporary shading is necessary during a couple of years. For this purpose *Tephrosia candida*

(Roxb.) DC., cadios, *Cajanus cajan* [Linn.] Merr. or banana, *Musa sapientum* may be used.

The temporary shades are not allowed to interfere with the free growth of the cacao trees. Every now and then the shade trees are pruned and thinned off as the permanent trees grow bigger.

Shallow cultivation or at least ring weeding is performed to enhance the growth of the plants. The former operation—shallow plowing—is practiced within the first two years to promote deeper rooting system. Ring weeding is done as often as three times a year or only in case the same is very necessary depending upon the growth of weeds.

Cacao, like many other fruit trees, needs judicious pruning not only to cut the dead, decaying, or diseased branches but also to get good formation of the crown and branches, using sharp pruning tools for the purpose. Cuts or wounds are painted with white lead or coal tar.

Pests and diseases.—Pests and diseases are the only limiting factors to the successful growing of cacao in the Philippines. These hazards, however, are now being overcome by improving the methods of culture and seed selection; by proper methods of control, by the proper use of shade, and by the use of other devices, all of which are now commonly practiced by the farmers.

The pod borer, *Acrocercops crameralla,* and the stem borer, *Zeuzera coffeae,* are the most serious pests attacking cacao trees in the Islands. These pests are controlled either by spraying, by collecting and destroying the beetles, by pruning and burning the dead and affected branches, or by dropping into the holes, in the case of the latter, carbon bisulfite or paradichlorobenzene. The holes are then plugged with wax, mud, or paraffin.

Other pests that are fairly serious at times are the mealy bugs, *Pseudococcus lilacinus* and *P. citri.* Both insects are controlled by soap solution (150 grams per kerosene can of solution), or by kerosene emulsion sprays.

Of the diseases, the most serious are the so-called black rot and canker, *Phytophthora faberi.* The former attacks the pods and the latter the stems. Spraying with Bordeaux mixture (4–4–50) or lime sulphur and observing strict sanitary measures in the plantation are the most effective control measures against these diseases.

Harvesting.—In general cacao trees in the Philippines begin to fruit in 4 to 5 years, or in some cases earlier. The flowers

develop into mature fruits in six months time. The fruits should be picked as soon as they are fairly matured or when they begin to show signs of ripening. If allowed to be over-ripe the seeds are liable to germinate and fermentation might occur. On the other hand, if the fruits are prematurely gathered, the seeds have no chance to ferment. Although a sharp knife or shears should be used in clipping off the pods so as not to injure the attachment, the present practice is to pick the fruits with the hands or with the use of a hook.

It is necessary that seeds be fermented in order to get the desirable taste and color as well as to kill the embryo. This is, however, an operation often overlooked by the average Filipino cacao growers, probably due to the fact that cacao is produced on a small scale at present. After washing the beans with clean fresh water they are dried in the sun. A complete dyring is indicated by a lustrous reddish-brown appearance of the bean surfaces. Beans thus dried break readily and with the inside of the kernels turned brown.

Uses and economic importance.—There are many uses of cacao in manufactures. Cacao is sold in the market as chocolate, ice-cream, powdered cacao, chocolate milk, cakes, cacao-nibs, cacao butter, cacao wine, chocolate soda, and in various forms of confectionery. It is likely that more uses of cacao will eventually be found. However, in the Philippines at present cacao is generally used only in making beverages, candies, or drinks.

In many places cacao has gained at once the fancy of users upon introduction. For instance, of the 250 tons consumed in 1882 more than half was consumed by the British navy. In 1888 English consumption increased to 9,000 tons and by about 1908 it had risen to 23,000 tons or more than one pound a year per capita.

The average increase in the world's consumption of cacao from 1932 to 1936 was from 0.69 to 1.56 per cent.

Statistics show that the United States is a potential market for cacao. Of the 41 countries importing cacao, the United States imports about 234,660 tons a year. Cacao is duty free both in the United States and in Holland, two great cacao-consuming countries. These two countries draw the bulk of their cacao imports from British West Africa, Brazil, Dominican Republic, Jamaica and Netherlands. Both America and Europe can consume a few thousand tons without in any way appreciably affecting the average wholesale price.

Cacao is now considered one of the world's staple crops. It is less susceptible to price fluctuations, and it can be kept for a long period.

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Hon. BENIGNO S. AQUINO

Secretary of Agriculture and Commerce

Hon. BENIGNO S. AQUINO

SECRETARY OF AGRICULTURE AND COMMERCE

A country gentleman, had he so chosen to remain and yet a public servant by force of circumstances, having served as a legislator in both Houses of the Philippine Legislature, first as a Representative and later as a Senator and still later as a member of the First National Assembly under the Commonwealth Government, that is the public record of the new Secretary of Agriculture and Commerce, Hon. Benigno S. Aquino who was inducted into office on November 28, 1938. Hon. Aquino brings forth into his exalted position not only an exuberant note of masculine vigour tempered with ministerial dignity which is as genuine as his political star but also the far-seeing eye of the statesman, developed during his many years of very close association with the foremost statesmen of this country, which is so necessary in our program of economic readjustment. The keen world struggle for supremacy in the possession of raw materials, not to mention the traditional itch for colonies of world powers as exemplified by very recent and actual world events, demands a re-orientation in our agricultural and fishing policies. His Excellency, President Quezon, is to be congratulated for having entrusted such a key position to this brilliant ex-legislator who is himself a successful landowner in Central Luzon.

The story of the composite life of Secretary Aquino literally bristles with political plums and plummage. Born in Concepcion, Tarlac, on September 3, 1894, young Aquino's richest heritage was his parents: General Servillano Aquino, wealthy rice planter of Central Luzon on the paternal side, and Guadalupe Quiambao, his mother.

As a boy he attended school in a private college in Tarlac thence moving over to San Juan de Letran College where he was graduated with the degree of Bachelor of Arts in 1908. There-

after he took up law in the University of Santo Tomas finishing the course in 1913 and passing the bar examinations the year after.

After five years of active law practice in his hometown, lawyer Aquino then conceded to be a leading figure in the Tarlac bar, presented his candidacy for a seat in the former House of Representatives, now defunct, in 1919. Beating to a punch predictions of political wiseacres who did not take him seriously then, he was elected to office in one of the biggest election landslides on record in Tarlac, with a majority of 2,000 votes in a district where there were barely 7,000 voters. Buttressed by his impressive record as a parliamentarian in his first term in the House, he was easily returned in the succeeding elections of 1922 and again in 1925. His political stock in the House was considerably bolstered up by his election to the post of majority floor leader in 1922, which position he held successfully for six consecutive years.

The year 1928 saw Secretary Aquino's star shine forth to larger destinies. For in that year, he became Senator-elect in a district which had been traditionally on the side of the oppositionists. He acquired prestige as floor leader of the Senate in 1930 and again as acting president of that body on various occasions during the illness of the President of the Senate.

In the First National Assembly under the Commonwealth Government he was chairman of the Commission on Appointments, the most important committee of that body, besides being a member of the Committees on Agriculture, National Defense, Ways and Means, and Pensions. His ministerial mettle, he proved unequivocably at the deliberations of the Inter-Parliamentary Union in Paris in 1927 to which he was sent as head of the Philippine delegation and again as special envoy of President Quezon to Washington when the discussion of the Independence Law was at its tensest in 1932. His political sagacity was amply demonstrated during the 1938 general elections when as general campaign manager of the Nacionalista Party candidates for Assemblymen he helped pull through each and every one of them to the dismay of all oppositionists. He is the sixth and youngest Secretary of Agriculture and Commerce.

Known to a few of his intimates as the Esquire of Concepcion, Secretary Aquino exemplifies the true gentleman. A man of his word and strong convictions, he dares oppose when to oppose is to be in the right. Even as he takes to his favourite stand

in the rostrum to pounce with driving force on the prophets of gloom and disaster and inject confidence in the national state of mind, the Commonwealth sees fit to forge ahead vastly assured that with the Department of Agriculture and Commerce in the hands of this man, the economic patrimony of the country will not be lost.

His views on Philippine economy and its implications may be gleaned from the following excerpts of a speech he, as Secretary of Agriculture and Commerce, delivered before the Convention of Provincial Governors and City Mayors held in Manila on January 20, 1939:

. . . The per capita average of our foreign commerce, based on the average of the last five years, amounts only to ₱32.52. Compared with the ₱53 for Japan, ₱75.30 for the United States, ₱285.50 for Great Britain, ₱116.60 for France, ₱108.00 for Germany and ₱127.50 for Cuba, ours is obviously insignificant. These figures clearly denote the relatively slow progress we have been making in the economic development of the country, a fact which is attributable only to the lack of efforts we have put forth in the past for the proper exploitation of our vast and promising resources. . . . An intensive exploitation of our natural resources is not only necessary to raise the standard of living of the greatest possible number of our citizens but also to provide adequate revenues for the support of our Government. . . .

The long wait, the lack of coördination, the absence of foresight and excessive red tape noticeable before a poor homesteader could establish his rights of settlement, are defects which the present administration is most desirous of correcting. . . .

. . . because of circumstances, many crops which now appear profitable may become adversely affected and eventually wiped out because of changes resulting from the readjustment of our political relations with the United States. . . . I do not overlook the need of readjusting our production through a campaign of diversification of crops. . . . Our country abounds in raw materials which, converted into cellulose, can be used in the manufacture of rayon. . . .

. . . . It is unnecessary for me to speak to you of other imports which we can easily produce in our country, such as paper, which costs us ₱6,000,000 a year; vegetables, fruits and nuts, another ₱6,000,000; coffee and cacao, ₱3,000,000; beef and dairy products, ₱10,000,000; other food products like fish, meat, confectionery, wines and liquor, ₱30,000,000. It is rather a sad commentary on a country like ours which, with the fertile fields it has for the production of the best kind of tobacco should have to import annually more than ₱15,000,000 worth of cigars and cigarettes. The explanation for this is the exotic influence on our tastes and habits. A coördinated campaign conducted especially by the provincial and municipal governments to bring home to our communities the need of injecting greater Filipinism into our customs and preferences, a campaign which would enhance the virtues of the race, and a constant preaching of prac-

tical nationalism which would arouse in the *masses* pride in what is our own, will serve greatly to reduce, if not totally eliminate these importations and thereby help place our national economy on a strong and durable basis. . . .

Secretary Aquino is married to the former Miss Aurora Aquino. They maintain a home at Concepcion, Tarlac, and another one in Manila.

CIGAR FILLER LEAF TOBACCO CULTURE IN THE PHILIPPINES

(Farmers' Circular 17)

By Domingo B. Paguirigan
Chief, Tobacco Research Section, Bureau of Plant Industry

and

Primitivo Tugade
Assistant Agronomist, Bureau of Plant Industry

TWO PLATES

Choice of varieties.—The varieties *Marogui, Viscaya, Simmaba* and *Pampano* are recommended for cigar filler culture. These varieties, when grown under shelter tents, are also wrapper varieties.

Soil requirements.—Cigar filler tobacco is best grown in rich alluvial soil. Sandy loam soils along the Cagayan river in the Cagayan Valley, which are inundated regularly, are the best filler tobacco districts of the country. The clay loam soils of the interior valleys of the Ilocos region also produce filler tobacco of good quality.

Climatic requirements.—Regions with short dry periods like the Cagayan Valley are most suitable for cigar filler tobacco. The Ilocos regions with well-defined dry and wet seasons are also filler tobacco producing districts but the crop is always inferior in quality because it is stronger, coarser, and has a tendency to yellow upon curing. While districts of abundant rainfall throughout the year may be adaptable to wrapper tobacco culture, yet for cigar filler tobacco such districts can not be recommended as the resulting crop is likely to be without body, taste (flavor), aroma, or gum—characteristics necessary for good filler.

The optimum seasonal periods of the different field operations for filler tobacco fall about the same as in the case of wrapper tobacco, viz.:

1. Seeding	September 15th to October 15th.
2. Transplanting	November 1st to December 30th.
3. First harvest	January 25th to February 1st.
4. Curing period	From 25 to 34 days.
5. No. of priming (harvest)	From 4 to 8 times.
6. Interval of priming	10 to 14 days.

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Location and preparation of seedbeds.—A higher ground than the regular tobacco field should be selected for seedbeds. It should be rich, loamy, near a water supply, and with good drainage. Virgin lands are most preferable if available. The land should be plowed and harrowed several times in August and September and finally divided into plots of convenient sizes. Between the beds must be paths of about half a meter wide, to serve as drainage at the same time. For convenience in many operations the beds should not be more than 10 meters long and 1.2 meters wide, each provided with inclined tents facing the east to protect the beds from strong sunlight and rain. Before sowing, the beds are finally worked out by garden tools, the soil pulverized and smoothed, and if necessary, sterilized. There are three practical ways of seedbed sterilization, viz.: pouring boiling water on the beds, burning dead vegetation on the beds, and by roasting the top soil on galvanized pans and returning the same to the beds afterwards.

Seeding.—Eight to ten grams of seed mixed with a chupa of wood ash is enough to cover a bed 10 meters long by 1.2 meters wide. The seed mixture is scattered sparsely and evenly over the bed and packed lightly with a wooden plank to keep the seeds firm in the soil. The beds are sprinkled with water to keep the soil moist. Ants usually become a menace during the germination stage as they carry the seeds away. To prevent this, corn meal with little sugar or coconut meal should be scattered around the beds. This bait will keep the ants busy, away from the seeds. A bed with the area mentioned above can readily supply 1,000 seedlings so that a hectare plantation requires no more than 15 seedbeds of good seedlings.

Care of seedlings.—The surface of the beds should be at all times kept moist. The seedlings will come up in seven days under normal conditions and will be quite big enough in 21 days. After 21 days, the tent of the beds can be removed to allow the seedlings to grow in the open. Keep the seedlings free from the weeds, taking care not to disturb them in weeding. By this time, the cutworms will begin to feed upon the tender leaves. To keep the worms under control the beds should be dusted periodically with a calcium arsenate mixture (one part calcium to 16 parts sterilized road dust). An ordinary cheesecloth bag becomes a handy duster merely by filling it with the arsenate mixture and shaking it gently over the seedlings.

Preparation of the field.—The land is first cleared of bushes, stumps and weeds, and then plowed and harrowed thrice before

the furrows are laid out. The furrows should be one meter apart one way and the cross furrows, 70 or 80 cm. apart the other way. The plants are set on every intersection of the furrows so that the planting distances are one meter between the rows and 70 or 80 cm. between the plants in the row.

Transplanting.—The seedlings should be ready for transplanting 54 to 60 days after sowing. Before pulling the seedlings, the beds should be sprinkled with water to soften the soil, thereby effecting less injury to the roots. On sunny days transplanting should be done only in the afternoons but if the weather is cloudy, planting can be done throughout the whole day, beginning early in the morning. By means of a trowel or a small bolo a hole is dug at the intersection of the furrows and the root of the seedling is inserted up to the neck. The root is covered with the surrounding soil and pressed firmly by the hand to brace the stem thereby allowing the seedlings to stand erect. The newly transplanted seedlings should be watered to hasten their recovery. Transplanting once started should not be stopped until the whole field is planted in order to obtain a uniform stand of crop which is very desirable.

Cultivation.—The first cultivation is given when the plants become well established and the second, usually the last, when they are about a foot high. Cultivation is done by passing the plow between the rows and heaping the soil along the rows of plants, thereby forming ridges. After the second cultivation the plants will then be too big to allow the work animal to pass through without breaking the leaves of the plants if these are of vigorous growth; otherwise a third and fourth cultivation may be necessary. The first cultivation should be done criss-cross, the second and subsequent ones only lengthwise.

Worming.—The picking of worms commences as soon as the plants are set in the field and is continued until the standard leaves are harvested. Since the worms feed mostly on the buds, care should, therefore, be exercised in worming so as not to break the growing points of the buds. Children can easily be taught to do this job properly.

Topping and suckering.—Topping is a necessary operation in cigar filler production and should be performed when the flower head is fully developed. Topping consists of the removal of the flower head by cutting it off with a pocket knife or a bolo. Suckering is a subsequent operation as the production of suckers from the axils of the leaves is stimulated by topping. Suckers

can easily be pinched off by hand when they are still tender; otherwise, when already big, the use of a knife is necessary to avoid injury to the bark of the main stem of the plant.

Seed selection.—Before the topping operation is performed the plantation should be gone over thoroughly to select the plants for seed production purposes. The plants selected should be bagged before the flowers open to insure self-pollination. The bags are removed as soon as the pods are formed. When the capsules are already mature, the whole flower head is cut off, bundled up in bunches and hung in the curing barn to dry. When dried, the capsules are threshed and the seed separated from the hull and stored in air-tight containers for future planting.

Harvesting.—The sand leaves often termed "palaspas" are harvested before the plants are topped. Cigar filler leaves are harvested at a more mature stage than wrapper tobacco. The changing of the color of the entire leaf from deep to light green, the yellowing of the margin and tip, sometimes the drying of the tip, and the conspicuous disappearance of the leaf hairs are some of the indications of maturity. Of course, experience is the safest guide. The leaves are primed, sometimes from four to six leaves being harvested from a plant at one time, and the interval of priming ranges from 10 to 14 days. The harvested crop is carried to the barn either on sleds or carts or wrapped in suitable mattings and carried overhead by men and women.

Poling.—The leaves are first classified as to size and soundness before they are poled on bamboo sticks called "palillos." These are about a meter long with a butt on one end and a sharp point at the other. With one hand holding the leaf and the other hand guiding the sharpened end, the worker guides the sharp end of the "palillos" and pierces the petiole of the leaf ventrally, then folds the leaf blade in such a way that the midrib is exposed. This operation is repeated until the stick is full of leaves. A stick can hold from 80 to 100 leaves, depending upon the size of the leaves and length of the "palillos." This method of poling tobacco is the prevailing system in the Cagayan Valley. The strung tobacco is hung on a rack and exposed to sunshine to wilt for three to five days, after which it is brought into the curing barn where the curing is completed by the action of air.

Curing.—The wilted tobacco is placed upon racks in the curing barn, every stick about a foot apart. By opening the windows and doors of the barn the crop dries gradually by the action of air until it is completely cured. At night, the ventilations are

closed to prevent cold wind and moisture from getting in, and during adverse weather charcoal braziers are built on the dirt floor of the barn to guard against excessive moisture. Curing should be complete in 27 to 34 days under ordinary conditions. A hectare of cigar filler requires a curing barn 12 meters long, 8 meters wide, and 4 meters high.

Fermentation.—A crop ready for fermentation should be thoroughly cured with the midribs well desiccated. The "palillos" are taken down from the racks when they are neither too soft nor too dry, and are piled into "mandalas" (piles of tobacco) for fermentation. The "mandala" is rebuilt 3 to 4 times, at 2 and 3 weeks intervals, to change the position of the crop so that the outer, bottom, and top portions of the pile will also be placed in the interior of the pile. Ordinarily, a crop of 40 quintals is fermented in two months. A good "mandala" for an ordinary crop of 40 to 50 quintals is 3 meters wide and 5 meters long, the height depending upon the quality of the crop. The crop, upon being piled, evolves heat which improves its color, texture and flavor. When the maximum temperature is reached the heat gradually falls and the tobacco is recognized as being thoroughly fermented. The tobacco is then removed from the stick, ready to be classified and bundled into "manojos."

Preparation of product for market.—The tobacco is sorted according to size, soundness, and fineness as per Internal Revenue regulations, bundled into "manojositos" of 100 leaves, and piled again one grade or class after the other. Ordinarily, the cigar filler crop is not baled by the producer, unless he desires to transport the product to distant markets, as representatives of buying firms are always stationed in the tobacco districts ready to buy the crop direct from the farmers.

ILLUSTRATIONS

Plate 1

Fig. 1. A typical plant of the Pampano, one of the best native varieties for cigar filler leaf tobacco production.

2. A partial view of a cigar filler leaf tobacco plantation of the Viscaya variety. This variety, when grown under partial shade, is also an ideal type for cigar wrapper leaf tobacco production.

Plate 2

Fig. 1. Tobacco seedlings of the cigar filler type, 21 days old, at the Los Baños Economic Garden, Los Baños, Laguna. The seedbeds were sheltered by abaca cloth.

2. A model tobacco curing barn for drying cigar filler leaf tobacco, Ilagan, Isabela.

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PLATE 1.

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2

PLATE 2.

THE CITRUS RIND BORER AND ITS CONTROL

(Farmers' Circular No. 48)

By CATALINO E. GARCIA

Assistant Agronomist, Bureau of Plant Industry

TWO PLATES

In the Philippines as well as in India, Ceylon, Malaya, and the Mediterranean region the citrus rind borer, *Prays citri* Milliere is one of the most serious pests of the pummelo, sweet orange, lemon, lime, and several other varieties including the wild citrus. The imported pummelo such as the Siamese, and the sweet orange varieties Valencia, Pineapple, Dougat, and others have been observed to be especially susceptible. The native lime has also been observed to be a favorite host.

The insect is destructive especially to young fruits causing them to fall off. The infestation starts after the withering of the petals of the flower, and the falling off of the fruits occurs before they are over 10 millimeters in diameter. Attacked young fruits are yellowish in color and their skin is depressed irregularly. Fruits that survive the attack produce galls or swellings on the rind, as shown in Plate 1, and such fruits are unsightly, often poor in quality and command low prices.

LIFE HISTORY AND HABITS

The moth is grayish brown with both pairs of wings fringed along the hind margin with fine hairs, as shown in Plate 2, Fig. 1. The adult insects are from 3.5 to 4.5 millimeters long, according to sex, and with a wing expanse of from 8 to 10 millimeters.

The female lays its eggs singly on the surface of the flower-buds and fruits, the latter being preferred. The eggs are almost circular in outline, creamy white, flat, like cakes, slightly convex on the upper or free surface and are about 0.5 millimeter in diameter. They turn light brown before hatching. They hatch in from 4 to 5 days, the average being 4.5 days.

On hatching the tiny caterpillar, which is about 1 millimeter long, bores into the rind of the fruit and feeds on the tissues

within. It is creamy white, cylindrical and with a brownish yellow head.

The larva remains within the fruit for 10 to 19 days, or an average of 13 days, after which it comes out. At this stage it is about 3.5 to 5.5 millimeters long and is greenish with brown spots on the lateral sides of each thoracic segment.

Pupation takes place in between overlapping leaves, on the lower surface of the leaf usually near the fruit, on twigs or at times on the fruit itself. The pupa is enclosed by loosely woven white cocoon. The pupa, which is about 4 to 5 millimeters long, is light green in color, but turns dark brown before emerging from the cocoon. It remains in the cocoon from 3 to 5 days, the average being 4 days.

The total span of life of the rind borer, from the laying of the egg to the emergence of the adults, is 17 to 29 days, with an average of 21 days.

During the months of January, February, and March when the pummelo, sweet orange, lemon, and lime are not in bloom or in fruit, the insect breeds on wild citrus, such as "bilolo" (Tagalog), "cabuyao" (Tagalog), and "goronguro" (Pangasinan) as these trees are ever-bearing. As soon as the pummelo, sweet orange, and other commercial species of citrus bloom, the insect migrates to them and lays eggs on their flowers and fruits.

CONTROL MEASURES

The following control measures have been practiced at the Tanauan Citrus Station, Tanauan, Batangas, and have given promising results:

1. *Spraying with derris-soap, prepared according to the following formula:*

Derris powder, fine (about 34 spoonfuls levelful)	120 grams
Soap powder or Chinese laundry yellow soap	300 grams
Water (or about one petroleum canful)	5 gallons

Spraying at weekly intervals, from the time the petals of the citrus flowers fall off until the fruits are about 7 centimeters in diameter in the case of the pummelo, about 5 centimeters in the case of "cajel," and about 2 centimeters in other varieties, was found to aid greatly in reducing the ravages of the pest. The eggs and pupae which are moistened by the spray are killed. The spray should be applied in a fine mist with a hand pump

provided with a long rubber hose and Bordeaux nozzle which are tied to a bamboo extension rod for tall trees. Thorough spraying is necessary, in order to drench the leaves and fruits and thus moisten the eggs and pupae.

2. *By poison bait, according to the following formula:*

Sodium arsenite	20 to 25 grams
Sugar (brown)	400 to 500 grams
Water	5 gallons

The sodium arsenite should first be dissolved in the water after which the sugar should be added and likewise dissolved by stirring with a bamboo or wooden stick. In view of the fact that *sodium arsenite is a violent poison, the hand should not be used in dissolving it and domestic animals should be kept away from the prepared bait. One should see to it also that it is not mistaken for drinking water.* After spraying the hands and equipment should be washed thoroughly. The bait should be applied in the evening by spraying it on the foliage of the citrus trees. The application of the bait should be done at intervals of seven days until the fruits are about 5 centimeters in diameter in the case of "cajel" and about 7 centimeters in the case of the pummelo.

3. *Collection and destruction of infested fruits.*—The young infested fruits that fall to the ground should be collected promptly for every fruit collected means a reduction of the rind borer population. Unless the fallen fruits are promptly collected, the larvæ will soon leave them and pupate on grasses and weeds. The fruits collected should be destroyed either by burying them deep in the ground or putting them for two days in strong soap solution after which they may be disposed of.

4. *By growing certain species of citrus as trap crops, such as Villafranca lemon, "calamondin," and Tahiti lime.*—It has been found out that the insect lays eggs on the fruits of these plants and the larvæ which are hatched from these eggs are abnormally weak and die before coming out of the fruits. Villafranca lemon, "calamondin" and Tahiti lime are, therefore, recommended as trap crops as their fruits are heavily attacked by the rind borer.

5. *Encouraging the multiplication of natural enemies.*—In the Tanauan Citrus Station, Tanauan, Batangas, two natural enemies were observed. One of them is the red ant "hantik," *Oecophylla smaragdina* which makes its nest in the tree and another is a hymenopterous insect which was found to parasitize the

pupa of the pest. The ant protects the fruits from being attacked by the borer. In China, the multiplication of this ant is said to be encouraged by putting the nests in the citrus trees to control a certain kind of leaf-eating insect. The only objection to this method is that it makes the picking of the fruits quite difficult for the ants' bite is painful. The ants also attend to scale insects, such as the green scale, and thus encourage their multiplication. However, if the ants become rather troublesome in this regard, they may be controlled by spraying with soap solution and poisoned syrup.

ILLUSTRATIONS

Plate 1

Citrus fruits attacked by the rind borer.

Fig. 1. Grapefruits
2. Oranges
3. Lemons

Plate 2

The citrus rind borer.

Fig. 1. Adult moth (× 10)
2. Egg (× 10)
3. Larva (× 10)
4. Pupa (× 10)

1 2 3

PLATE 1.

Fig. 1

Fig. 2

Fig. 3

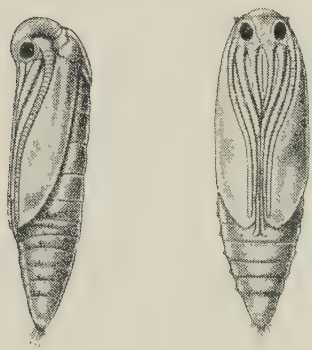

Fig. 4

PLATE 2.

BUREAU OF PLANT INDUSTRY

AGRICULTURAL STATIONS

1. Central Experiment Station, Manila
2. Lamao Horticultural Station, Limay, Bataan
3. Lipa Coffee-Citrus Station, Lipa, Batangas
4. Tanauan Citrus Station, Tanauan, Batangas
5. Granja Sugar-Cane Station, La Granja, Occidental Negros
6. Gandara Seed Farm, Gandara, Samar
7. Baguio Plant Industry Experiment Station, Baguio
8. Maligaya Rice Station, Muñoz, Nueva Ecija
9. Ilagan Tobacco Station, Ilagan, Isabela
10. Maridagao Rubber Station, Pikit, Cotabato
11. La Paz Propagation Station, La Paz, Iloilo
12. Los Baños Economic Garden, Los Baños, Laguna
13. Sta. Maria Propagation Station, Sta. Maria, Ilocos Sur

SUBSTATIONS

1. Davao Seed Farm, Davao Penal Colony, Davao
2. Halcon Rubber Substation, Baco, Mindoro
3. Gingoog Lanzon Reservation, Gingoog, Oriental Misamis
4. Mandaue Seed Farm, Mandaue, Cebu

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